Developing siblings and peer tutors to assist native Taiwanese children in learning habits of mind for math success.

Hsing-Wen Hu
University of Massachusetts Amherst

DEVELOPING SIBLINGS AND PEER TUTORS TO ASSIST NATIVE TAIWANESE CHILDREN IN LEARNING HABITS OF MIND FOR MATH SUCCESS

A Dissertation Presented

by

HSING-WEN HU

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

May 2005

Education

DEVELOPING SIBLINGS AND PEER TUTORS TO ASSIST NATIVE TAIWANESE CHILDREN IN LEARNING HABITS OF MIND FOR MATH SUCCESS

A Dissertation Presented

by

HSING-WEN HU

Approved as to style and content by:

Ernest D. Washington

Ernest D. Washington, Chair

Grace J. Craig

Grace J. Craig, Member

J. Kevin Nugent

J. Kevin Nugent, Member

Jean S. Forward

Jean S. Forward, Member

Andrew Effrat, Dean
School of Education

ACKNOWLEDGMENTS

I would like to thank my advisor, Ernest D. Washington, for his many years of thoughtful, patient guidance and support. I would also like to extend my gratitude to the members of my committee, Grace J. Craig, J. Kevin Nugent, and Jean S. Forward, for their helpful comments and suggestions at all stages of this dissertation.

I want to thank my friends, Shilan Pisuy and Chiway Lo, whose encouragement and assistance helped me to finish this study. My appreciation also goes to the Jeso and Sangmin elemetray schools teachers, who gave me the permission to do this project in their classrooms, helped me organized all the work, and did the assessment of students' work.

Thanks to all the individuals who volunteered their participation in this project. Without their participation, this document would never have been completed.

Most important, I thank my wife, Joy, my children, Mary and John and all the family members, who have supported my educational goals and helped me finish this study with dignity.

ABSTRACT

DEVELOPING SIBLINGS AND PEER TUTORS TO ASSIST NATIVE TAIWANESE CHILDREN IN LEARNING HABITS OF MIND FOR MATH SUCCESS

MAY 2005

HSING-WEN HU, B.A., NATIONAL HSINCHU TEACHERS COLLEGE

M.Ed., NATIONAL TAIPEI TEACHERS COLLEGE

Ed.D., UNIVERSITY OF MASSACHUSSETS AMHERST

Directed by: Professor Ernest D. Washington

The purpose of this study was to explore at-risk (Native Taiwanese) children's habits of mind applying Vygotsky's ZPD theory in learning habits of mind in math. Workshops were used to teach pairs of siblings' habits of mind.

The study was conducted with 62 subjects and 62 siblings or older peers in two elementary schools. Each pair was randomly assigned into either the experimental or the control group. Siblings who were in the experimental group participated in the workshops to receive training that could help the experimental subjects to learn habits of mind. A pretest and a posttest were given to assess their habits of mind in math. Analysis of data revealed no significant differences between experimental group and control group in the pretest. In the posttest, there were significant differences between experimental group and control group in the areas of patterning, describing, and visualizing, but there was no significant difference in the "experimenting" condition.

In summary, the data shows that patterning is easy to learn, visualizing come next, describing is more difficult, and experimenting is the most difficult. All of these habits of

mind can be learned through applying Vygotsky's ZPD theory and using sibling workshop, but there is a need for the students and siblings to have extensive time to practice.

CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTIONS

Statements of the Study

Native people were present on Taiwan one thousand five hundred years before the arrival of Chaing Kai in 1950. Three million people came to Taiwan with the defeat of the Nationalists by the People's Republic of China. At that time, there were nine tribes of Native Taiwanese. They are Saisiat, Bunun, Tsou, Rukai, Paiwan, Atayal, Amis, Puyuma, and Yami (Chen, 1992). These groups differed from each other with regard to culture and language. According to statistics of the Taiwanese Government, there were 369,000 Native people in 2001. They tend to live in inconvenient and remote places, and therefore, Native Taiwanese people and their children have limited resources (Chen, 1990; Wu, 1992).

Many studies have found that Native Taiwanese students' academic achievements are far below average, especially in mathematics (Chien, 1990; Kuan, 1987; Lu, 1987). The factors that explain this include: first, Native Taiwanese children experience more stresses because they face a new environment, culture, and learning styles that differ from their cultural experiences (Chen, 1993; Lee, 1990; Wang, 1992). Second, the current curriculum is not suited to Native Taiwanese children. According to Lee's study (1996), Native Taiwanese students have difficulties with the current curriculum of mathematics. The curriculum needs to be simplified for them (Lai, 1995; Tan, 1995). Third, Native Taiwanese children have little interaction with capable peers. The total population of

Native people is small, and many schools do not have very many students, so that they do not have many options to learn from and interact with other people (Yu, 1993). Fourth, Native Taiwanese children lack family involvement in their education. In general, Native Taiwanese parents often do not have high expectation for their children's education. They think that teachers should bear the most responsibility for their children's education (Yang, 1992). Therefore, Native Taiwanese children's families do not often join in school activities (Mei, 1995).

Family involvement in children's learning math at school and at home is a key component of education (Desimone, 1999; Kokoski, 1995; Neil, 1994; Standing, 1996). Therefore, there have been many intervention designed to increase family involvement. However, the majority of studies do not identify a clear role for the family to play in the children's education. Moreover, much of the research regarding family involvement is deficient in breadth and devoid of content. This is especially true regarding family involvement for children who are at-risk for academic failure in mathematics education (Dominic, 1996).

Traditionally, at-risk children, such as native people's children, and low-income children, have not excelled in math (Dominic, 1996; Schwartz, 1987). Often the lack of literacy and achievement in math is due to the following factors: 1) cognitive difference between how the information is presented and how the children processes it; 2) lack of familiarity because of cultural differences between the school and the context in which the material is taught; 3) family stress due to poverty and unemployment; 4) racial and cultural biases that may lead teachers and parents to believe that native children can not learn (Schwartz, 1987).

This study first identified some effective principles and strategies that may help families to prepare the environment to improve children's learning. A range of policies, programs, methods concerning family literacy in mathematics, and from the literatures was reviewed to determine what kind of family environment is helpful for at-risk children's math learning. This review also revealed that siblings or capable peers could be a supporting resource when their parents might not be able to be involved in their children's learning.

Second, the concept of habits of mind of math was clarified. "Habits of mind of math" are a group of dispositions that can help children to think about mathematics the way mathematicians do. These habits include helping children learn to "sniff" patterns, experiment, think, describe, invent, visualize, conjecture, and guess (Cuoco, 1996).

Third, the theoretical approach used here is focused on the work of Vygotsky who was concerned with educating children who were considered at risk following the Russian revolution. His theory emphasized educational development that he defined as what the child could accomplish with a helper. Teaching and learning took place within a zone of proximal development where the children were guided by a teacher, parent, sibling, or a capable peer. The emphasis in this study was focused on helping siblings or capable peers create a zone of proximal development, so that at-risk children can learn the habits of mind that are necessary for success in mathematics.

After defining family involvement, habits of mind in math, and Vygotsky's ZPD theory, the experiment was arranged for subjects and siblings. All subjects were randomly assigned to the experimental and control groups, and participated in the processes of the pretest and posttest. Siblings whose brothers/sisters were in experimental group joined the workshop to learning how to teach habits of mind of math. The data were analyzed using statistical methods. Finally, the study found some effective principles and strategies that could help families and teachers improve children's math learning, especially at risk students.

Research Questions

The following section will identify a series of research questions that will guide the collection and analysis of data in accord with the purpose of the study:

1. What are the definitions of at-risk (Native Taiwanese) children's habits of mind of math?
2. Is it possible to operationalize habits of mind, so that they can be taught by siblings?
3. Can the Vygotsky's ZPD theory be applied in sibling-sibling or peer-peer's interaction to learn habits of mind of math?
4. Are there significant differences between the experimental group and the control group after workshops for learning the habits of mind of math are made available for the siblings of the experimental group?
5. Are there differences among the following habits of mind: patterning, experimenting, describing, and visualizing?

Definition of Terms

Native Taiwanese: Native Taiwanese are a group of people who were the early settlers in Taiwan. There are nine tribes of Native Taiwanese—Saisiat, Bunun, Tsou, Rukai, Paiwan, Atayal, Amis, Puyuma, and Yami (Chen, 1992). The total population is 369,000 (Ministry of Interior, 2001). Most of them live in the inconvenient and remote areas. Overall, they have low socioeconomic statuses in Taiwan.

At-risk children: At-risk children are disadvantaged groups, such as native people, this group usually includes low-income children, and racial minorities, who have a high probability of not receiving sufficient care and education to succeed (Abdal-Haqq, 1993; Pallas, 1989; Pollard, 1999; Rodriguez, 1997).

Family involvement: Family involvement includes three basic types of interaction and intervention—parental, sibling, and extended family, and each plays an important role in children's learning and development (Barker, 1998; Turnbull, 2001).

Habits of mind of math: Habits of mind are a group of dispositions that are observable. These behaviors could become habitual actions through discipline and practice (Arthur, 2000; Katz, 1999). There are eight habits of mind of math that have been identified in the math literature--patterning, experimenting, describing, tinkering, inventing, visualizing, conjecturing, and guessing (Coxford, 1998; Cuoco, 1996). The four habits of patterning, experimenting, describing, and visualizing were chosen because they can be operationalized. Each will have a four point ranges: expert (4), practitioner (3), apprentice (2), and novice (1).

Patterning: Pattering is one of the habits of mind of math in this study. It includes two aspects: first, P1 refers to "looking for a pattern." In the P1, the scores were defined as: expert (4)—subjects search 3 times for the pattern when solving a math problem; practitioner (3)—subjects search 2 times for the pattern when solving math problem; apprentice (2)—subjects search one time for the pattern when solving math problem; novice (1)—subjects do not search for the pattern when solving a math problem. Second, P2 refers to "being able to find hidden patterns in the context of math." In P2, the scores were defined as: expert (4)—subjects can find patterns in the context of math and analyze the characteristics of pattern completely and accurately; practitioner (3)—subjects can find patterns in the context of math and analyze the characteristics of pattern completely; apprentice (2)—subjects can find patterns in the context of math, but can't analyze the characteristics of pattern completely and accurately; novice (1)—subjects can't find patterns in the context of math and analyze the characteristics of pattern completely and accurately.

Experimenting: Experimenting is the one of the habits of mind of math that includes three aspects: First, E1 refers to the speed in "responding to the math problems." In the E1, the scores were defined as: expert (4)—subjects respond problems under 5 seconds; practitioner (3)—subjects respond problems from 5 second to 10 seconds; apprentice (2)—subjects respond problems from 11 to 15 seconds; novice (1)—subjects respond problems over 16 seconds. Second, E2 refer to "concentrating on processes." In the E2, the scores were defined as: expert (4)—subjects concentrates very intensely in the process of solving problems (under 5 times); practitioner (3)—subjects concentrates in the process of resolving problems (5 to 10 times); apprentice (2)—subjects concentrates on the process of resolving problems (11 to 15 times); novice (1)—subjects do not concentrate on the process of resolving problems (over 16 times). Third, E3 refers to "working fluently." In the E3, the scores were defined as: expert (4)—the processes are very fluent in subjects' works (over 3 times); practitioner (3)—the processes are fluent in subjects' works (2 times); apprentice (2)—the processes are less fluent in subjects' works (1 time); novice (1)—the processes are not fluent in subjects' works.

Describing: Describing is the one of the habits of mind of math and it includes two aspects: First, D1 refers to "giving precise descriptions of the steps in a process." In the D1, the scores were defined as: expert (4)—subject gives precise and complete descriptions of the steps in a process; practitioner (3)—subject gives complete descriptions of the steps in a process; apprentice (2)—subject gives incomplete descriptions of the steps in a process; novice (1)—subject can't give descriptions of the steps in a process. Second, D2 refers to "giving precise descriptions of results." In the D2, the scores were defined as: expert (4)—subjects writes down his/her thought, results, conjectures, arguments, proofs, questions, and opinions precisely and completely; practitioner (3)—subject writes down his/her thought, results, conjectures, arguments, proofs, questions, and opinions completely; apprentice (2)—subject writes down his/her thought, results, conjectures, arguments, proofs, questions, and opinions incompletely; novice (1)—subject can't write down his/her thought, results, conjectures, arguments, proofs, questions, and opinions.

Visualizing: Visualizing includes two aspects: First, V1 refers to "constructing tables and graphs." In the V1, the scores were defined as: expert (4)—subject constructs precise and complete tables or graphs from descriptions of math problems; practitioner (3)—subject constructs complete tables or graphs from descriptions of math problems; apprentice (2)—subject constructs incomplete tables or graphs from descriptions of math problems; novice (1)—subject can't construct tables or graphs from descriptions of math problems. Second, V2 refer to "finding effective clues from tables or graphs." In the V2, the scores were defined as: expert (4)—subject finds precise and complete clues that can solve math problems from the tables or graphs; practitioner (3)—subject finds complete clues that can solve math problems from the tables or graphs; apprentice (2)—subject finds incomplete clues that can solve math problems from the tables or graphs; novice (1)—subject can't find clues that can solve math problems from the tables or graphs.

ZPD theory: Vygotsky defined two levels of cognitive development. The first was the child's actual developmental level, as determined by his independent problem solving. The second was his level of potential development, as determined by the kind of problem solving the child could do under adult guidance or in collaboration with a more capable peer. The distance between these two points was called the zone of proximal development (Craig, 1996).

Sibling workshop: Siblings whose brothers/sisters participated in the experimental group received training for in teaching habits of mind of math, so that they could share their knowledge and experience with their brothers/sisters.

Significance of the Study

At-risk children have many challenges in math learning such as having difficulties with understanding the abstract nature of math. However, teaching habits of mind in math opens a new way for them to learn math. At-risk children can easily perceive and understand strategies for solving problem through applying the habits of pattering, experimenting, describing, and visualizing. Moreover, applying Vigotsky's ZPD theory in this study may confirm that siblings or older peers are capable of learning resources if these siblings or peers receive adequate training. The results of the study revealed that siblings or older peers are an important supporting system for at-risk children to learn the habits of mind. Finally, the sibling workshop makes learning habits of mind of math and sibling involvement blend together successfully.

Limitation of the Study

The time span of the study is one of its limitations. It began in December 2003 and ran through the end of April 2004 because this was the only time available. The operation of workshops and the interactions between sibling and subjects were too brief to develop strong habits over such a short time. In other words, to learn habits of mind requires a long period of time for workshops and sibling-subject interaction.

The research samples and sampling areas are another limitation in the study. There were 62 subjects and 62 siblings participating the study that came from two schools. However, there are nine ethnic groups of Native Taiwanese. It is better to choose samples from these races and increase the numbers of the sample. Therefore, the study might gain more generalizability.

The final limitation is the lack of a developmental study of habits of mind in math. For example, a systemic framework has not been developed to analyze the relationship between children's math achievement and habits of mind of math. In addition, effective methods for evaluating habits of mind of math also have not been found. If these factors could be resolved, the application of the habits of mind of math would be easier.

CHAPTER 2

REVIEW OF THE LITERATURE

This review examines math learning in at-risk children. The researcher further wants to identify more strategies for helping at-risk children learn math. Finally, the summary will conclude directions and principles for designing the experiments in this study. This is a selective review of the literature because the research on at-risk children is voluminous.

Math Learning in At-risk Children

Math is an important foundation in the subjects that are related to the sciences. Likewise, applicants for better employment need a firm grasp of these subjects. However, at-risk children have not excelled to the same degree as others in these areas (Schwartz, 1987). In this section, the characteristics of at-risk children will be discussed first. Second, the causes of at-risk children failing in math learning will be examined. Third, some successful programs and methods for at-risk children learning math also are discussed.

At-Risk Children's Characteristics

Identifying at-risk children is not easy because it is related to special cultural, linguistic, or ethnic populations and specific local communities (ERIC clearinghouse on languages and linguistics, 1997). In addition, if we want to describe them, this population needs to be evaluated through various instruments (Donnelly, 1987). However, we can begin with the definition of at-risk children found through reviewing the literature.

Therefore, a tentative definition of at-risk is "Children who have a high probability of not receiving sufficient care and education to become independent, successful, and productive adults (Abdal-Haqq, 1993; Pallas, 1989; Pollard, 1999; Rodriguez, 1997)".

Examining at-risk children carefully, we find they have external and internal characteristics. First, at-risk children have discouraging circumstances. They include: 1) Poor family background-- low socioeconomic status, parents may have low educational backgrounds and may not have high educational expectations for their children; low parental involvement (Bauer 2001; Donnelly, 1987); 2) Low academic achievement; test poorly in mathematics (Donnelly, 1987; Green, 1995; Howerton, 1994); 3) Lacking in social skills-- tend not to participate in school activities and have a minimal identification with the school, peer relationships are problematic, and racism (Donnelly, 1987; Lamorey, 1999); 4) Disciplinary and truancy problems lead to credit problems, impulsive behavior, drug addictions, pregnancies, alcohol abuse, tobacco use, and domestic violence (Donnelly, 1987; Lamorey,1999; Sugland, 1993). Second, at-risk children tend to exhibit low self-esteem, need to develop critical thinking and self- expression, low motivation, lack of consistency, and low stimulate inquiry (Bauer, 2001; Donnelly, 1987; Howerton, 1994; O'Thearling, 1996).

Causes of At-risk Children not Being Successful in Math Learning

The abstract nature of math material, differences in learning styles, lack of school supports, weakness of family involvement, and bias of cultural interaction are the main causes for at-risk children being not successful in math learning.

Abstract Nature of Math Materials

Connor (1990) examined a computer-based mathematics learning activity for low-achieving and/or at-risk 10th, 11th, and 12th grade inner-city students. He found that students who had difficulties with arithmetic in the past, tended to find the process of mathematics learning much more difficult due to its abstract nature. In addition, children's lack of familiarity with abstractions causes differences because of cultural differences with the context in which the material is taught (Schwartz, 1987).

Differences of Learning Styles

At-risk children's learning styles are related to their self-esteem, learning knowledge and skills, and cognitive development. If they have low self-esteem, inadequate math knowledge and skills, and different development in cognition, at-risk children are likely to have difficulties in math learning. For example, Howerton (1994) investigated self-esteem and achievement of 42 black male rural junior high school students identified as at-risk by their teachers. He found that self-esteem was significantly related to achievement test composite scores and science and mathematics subtests. Kasten (1988) also found that two groups of students at risk of not developing adequate mathematical knowledge and skills did not achieve at a satisfactory level in mathematics and enroll in mathematics courses beyond typical required courses. In addition, Schwartz (1987) studied teaching science and mathematics to at-risk students and found a cognitive difference between how the information is presented and how the students process it. This problem is a perennial difficulty in working with at risk students.

Lack of School Supports

If schools accommodate to the math and students` learning styles, it would increase students' school attendance. In Brickle's (1990) study, he attempted to improve the problem-solving skills of a group of 50 alternative high school students by strengthening these students' appreciation of and interest in mathematics, by increasing attendance in mathematics classes, and by improving students' performance on the school's standardized basic skills test in mathematics. He found that low attendance and the lack of effective, alternative classroom learning strategies are factors that mitigate against students' interest and success in mathematics.

Weakness of Family Involvement

Family stress is a further cause of lack of success. Schwartz (1987) argued that family stress is one of the factors that influenced math learning of at-risk children because children whose families are in turmoil usually suffer from lack of parental involvement. Further, the child's ability is blocked by low self-esteem that is a result of the internalization of this stress. The prime sources of family stress for children at academic risk for problem in learning behaviors are poverty and unemployment or overload (Galambos, 1995; Schwartz, 1987). In addition, parents lack positive attitudes toward mathematics and understanding of current methods of teaching math (Onslow, 1992).

Bias of Cultural Interaction

Rosebery (2000) found that children from culturally and linguistically diverse backgrounds represent the fastest growing school-age population in the United States and many of these children are failing in science and mathematics. Schwartz (1987) further suggested that racial and cultural biases may lead teachers and parents to believe that at-risk children cannot get jobs in technology or are not suited for them, and therefore they should not waste time learning the subjects (math and science) that will be of no career use.

Successful Examples of Supporting At-risk Children Learning Math

Recently, many studies have investigated programs and developed new strategies to respond to the previous five factors. They include developing effective programs and methods for teaching from school, improving family function, and connecting resources with the community.

Developing Effective Teaching Programs and Methods from School

Modern technologies are an effective way to support at-risk children in math learning, especially the uses of computer. Computers integrate curriculum, learning strategies, and teaching methods to help children in learning math and building up adequate learning habits (Brickle, 1990; Bryant, 1992; Connor, 1990; Elliott, 1997). For example, Connor (1990) designed computer-based mathematics learning activities for at risk students in mathematics learning. The project fostered the motivation necessary for the students to reach the project's objective and produce a graphic image which is a reflection of what that student had learned. The result was that students involved in the project displayed a significant improvement in attendance patterns that manifested itself in an overall improvement in assignment completion, as well as moderate increases in achievement levels.

Teaching methods or strategies play an important role in at-risk children's math learning. However, the research indicated that teaching methods or strategies are related to teachers' beliefs and training (Tobias, 1992). One example of teacher strategies was illustrated by Brickle's study (1990). He found that the lack of effective, alternative classroom learning strategies were factors that mitigated against students interest and success in math, particularly at-risk students. He suggested that the design of mathematics instruction to accommodate differences in students' learning preferences was an effective strategy for addressing the unique needs of the at-risk students. In addition, it is helpful to give children early mathematics intervention. However, teachers need to be trained to identify children who need intervention, to take part in the collaborative process; and to view them as part of a team effort to address the learning development of children in math (Abdal-Haqq, 1993). Therefore, a workshop is needed for training teachers. Bryant (1992) designed a study to improve math achievement of at-risk children and found that an in-service workshop was an excellent way to familiarize teachers with math learning strategies.

Language abilities are important because they increase problem solving abilities, self-confidence, and self-esteem in math (Intercultural Development Research Association, 1996; ERIC Clearinghouse On Languages And Linguistics, 1997). Effective math learning is based on the abilities to "understand math" and "speak math." In addition, the more children have mastery of the language of instruction, the more they have self-confidence and self-esteem in math learning (Howerton, 1994).

Improving Family Supporting Functions

Family supports in children's math learning should focus on increasing parents' participation, overcoming math anxiety, and encouraging mathematics participation (Caldwell, 1989). Families need to use the home culture as a springboard to learning math (Intercultural Development Research Association, 1996). In other words, programs for children should match parents' cultural experience. Sears (1992) attempted to integrate native people's culture into math materials, so that he designed the following activities: (1) the provision of start-up supplies and other materials to the children and their families; (2) an initial meeting to explain the project and the proper use of the material to their families; (3) a portable computer; (4) a math fair; and (5) the distribution of materials for the summer. After participants joined the project, children were tested for verbal, math, and social skills, and parents were surveyed. Participating students had higher scores than the children of the previous year.

Connecting Sources from Communities

The resources of the community that come from colleges, associations, businesses, and government supply another way to help at-risk student in math learning (Intercultural Development Research Association, 1996). TAAS (Texas Assessment of Academic Skills) developed a program to help Texas students, especially minority and disadvantaged students to master the state math test. It created a collaborative effort among education, business, government, and community to provide Texas communities with the resources to implement contemporary, rigorous, and engaging mathematics education for at-risk children (Intercultural Development Research Association, 1996). In Edwards (2001)'s study, he described a mathematics-focused summer camp for inner city, African American, at-risk children. The camp grouped participants with college students and professional mathematicians. Results of pre- and posttests indicated that children's mathematics scores increased significantly. Both participants and tutors had positive reactions to the experience.

More Strategies for Helping At-risk Children Learning Math

Traditionally, at-risk children have not excelled in math. Some studies have found effective ways to improve math learning in at-risk children as in the previous descriptions. This study attempted to find more effective paths to advance at-risk children's math learning through integrating the functions of habits of mind in math, Vygotsky's ZPD theory, and family involvement.

Developing At- risk Children's Habits of Mind in Math

Building up children's habits of mind will let students be more disposed to draw upon the habits when they are faced with an uncertain or challenging situation because it provides conceptualization of reasoning, producing awareness of thinking, and supporting higher order thinking (Arthur, 2000; Bashmueller, 1992; Dods, 1996; Drake, 1997; Mcgee, 1996). The contents and measuring methods of habits of mind will be introduced in the following section.

Concerning Habits of Mind

Katz (1999) argued that habits of mind are dispositions to respond to certain situation in certain ways. Arthur (2000) further indicated that "habits of mind" are behaviors that are practiced until they become a habitual way of working toward more thoughtful, intelligent action. Therefore, we may say that habits of mind are a group of dispositions, and these dispositions are observable and teachable behaviors. These behaviors become habitual actions through discipline and practice.

There are many habits of mind found in different fields. In other words, different subjects may have varied habits of mind. For example, in the science area, skepticism and curiosity are emphasized, where discerning the common phenomena and making historical comparisons are important habits of mind in history class. However, we still may categorize these habits of mind into concepts, skills and emotions. Habits of mind concepts include thinking about thinking, questioning and posing problems, applying past knowledge to new situations, creating, finding and keeping focus; searching for patterns, using models and metaphors, discerning the common phenomena, identifying new ideas, making comparisons, awareness, reasoning, inventing (Arisa, 1998; Arthur, 2000; Cook, 1996; Coxford, 1998; Cuoco, 1996; Organization of History Teachers, 1993). The skills of thinking and communicating with clarity and precision included gathering data through all senses, thinking interdependently, designing tests and experiments, finding an elegant solution, cooperating and collaborating, competing, visual thinking, making and checking conjectures, providing convincing arguments, guessing, describing, imagination, etc (Arisa, 1998; Arthur, 2000; Cook, 1996; Coxford, 1998; Cuoco, 1996; Organization of History Teachers, 1993; Richardson, 1996; Volkmann, 1999). Habits of mind in emotions include persisting, managing impulsivity, listening with understanding and empathy, thinking flexibly and fluently, striving for accuracy, responding with wonderment and awe, taking responsible risks, finding humor, remaining open to continuous learning, attentiveness, perseverance and self-discipline, sensitivity, appreciation, skepticism, objectivity, curiosity, wonder (Arisa, 1998; Arthur, 2000; Bailin, 1999; Cook, 1996; Coxford, 1998; Cuoco, 1996; Organization of History Teachers, 1993; Richardson, 1996; Sher, 1992; Van Tasselo-Baska, 1998; Volkmann, 1999).

Through the practice of math, the following habits of mind are created: patterning, experimenting, describing, tinkering, inventing, visualizing, conjecturing, and guessing (Coxford, 1998; Cuoco, 1996). First, children should be able to look for patterns and find hidden patterns in the context of math. Second, children should be experimenters who when faced with a math problem immediately start playing with it with concentration and fluency. Third, the habit of describing is to give a precise description of steps in a process. Fourth, children should develop the habits of taking ideas apart and putting them back together. Fifth, children should develop the habits of doing math both for utilitarian purposes and for fun. Sixth, children should construct tables and graphs to use these visualizations in the process of resolving problems. Seventh, the habit of making plausible conjectures takes time to develop, but it is central to the doing of math. Eighth, guessing is a wonderful research strategy that often helps us find a closer approximation to the desired result (Cuoco, 1996).

Measuring Methods of Habits of Mind

Although there are no systematic methods and standards to measure habits of mind, we still can evaluate them through observation. The first step is developing an observational study to define in precise terms what will be observed (McMillan, 2001). Since it is impossible to observe everything that occurs, we must decide on the variables of analysis that are most important and then define the behavior so that it can be recorded objectively. With these definitions of habits of mind as a starting point, the focus will be on one or more aspects of children's actions related to habits of mind in math. Calhoun (1993) identified the following processes of researching habits of mind: 1) Selecting a focus—Selecting a specific area of concern about children's habits of mind we want to investigate; 2) Collecting data—using duration recoding that indicates the length of time a particular kind of behavior lasts; 3) Organizing data—sorting and categorizing the information we acquire through our data collection process; 4) Analyzing and interpreting data—drawing conclusions about the data we have collected.

Intensifying Family Involvement

There are different opinions among researchers as to what constitutes effective family involvement, but most of them support the educational policy direction of increasing family involvement. This implies that family involvement plays an important role in children's learning. In the following section, reasons for family involvement, factors influencing involvement, and methods for intensifying family involvement will be discussed.

Reasons for Family Involvement

Family involvement is critical to children's success during the school years (Ballantine, 1999). Hornby (2000) reviewed the literature on family involvement and found that involving family promotes children's achievement from pre-school through secondary education. The benefits of family involvement firstly for children include: improves academic performances, helps facilitate proper attitudes and behaviors, higher school attendance and less disruptive behaviors, increases the likelihood of completing high school and attending college, and improves study habits. Second, involvement of family increases self-confidence, improves communication within family, increases parental satisfaction with school, supplies a sense of accomplishment for family, sets higher parental expectations of children, and increases the likelihood of parents deciding to continue their own education. Third, positive parental attitudes toward teachers and schools improve teacher morale, improve school climate, and overall school improvement (Ballantine, 1999; Karther, 1997; Sussell, 1996).

Factors of Influencing Family Involvement

Family involvement is influenced by many factors: culture, social class, dwelling environment, community activity, demographic change, and interaction between family and school.

First, culture and cultural identity influence parents' childrearing practices and orientation toward formal education (Espinosa, 1995; Pfleger, 1985). Hornby (2000) also argued that culture might directly or indirectly influence parents' attitudes and beliefs that form the parents' background of caring about the education of their children.

Second, different social classes produce different forms of parental involvement (Ascher, 1988). For example, Tudge (1997) compared child's rearing values in different social classes and found that middle-class parents rated self-direction higher, and control and discipline lower, than working-class parents, and were less likely to be concerned with spoiling their children by giving them more attention than working-class parents. In addition, middle-class children were more likely than working-class counterparts to be involved in academic or skill/nature lessons. Middle-class children were more likely to initiate activities of interest than were their working-class counterparts.

Third, housing and living environment influence the quality of family involvement. Most poor urban children live in single parent, female-headed households, and many school officials tend to decide in advance that single and working parents cannot be approached or relied upon. Family involvement in school activities is related to the flexibility of leave policies on their jobs, employers are encouraged to allow flextime to enable working parents to observe their children in the classroom or attend meetings (Ascher, 1988).

Fourth, community activities influence family involvement. Parents or family members are expected to take part in discussions about school policy, child development concerns, and curriculum planning and evaluation. Therefore, the family role mirrors the community's, at both the school wide and the classroom level (New, 1993). However, Hornby (2000) observed that in Barbados, families are traditionally not expected to be involved in schools or even in educating their children at home. This is one example of the social or cultural factors influencing family involvement.

Fifth, demographic changes have made family involvement more difficult, especially in the interaction between parents with school. Two major reasons are: 1) a majority of mothers of school-aged children are now in the workforce; 2) the increased rate of divorce produces a substantial proportion of living in single-parent families. When both parents are working or there is only one parent in the home it is much more difficult for these parents to have high levels of involvement in their children's education (Hornby, 2000). Finally, interactions between teachers (schools) with family are important factors in school culture, school policy and procedures, teacher training, and teacher attitudes that influence children's learning (Ascher, 1988; Hornby, 2000).

Methods of Intensifying Family Involvements

Family involvement can be divided into children's education at home and involvement in school activities. Family contextual variables included the physical environment and psychological environment of family. School level variables consisted of school climate and family-school communication (Becker-Klein, 1999). Home-based and school-family family involvement will now be discussed.

Advancing Home-based Family Involvement

Many studies have shown family background to be the most important influence predicting a child's performance in school and have begun to identify the family attitudes and behaviors that form children's learning styles and behavioral models (Hanson, 1985). The physical environment and psychological environment of the family are the crucial items in home-based parent involvement. Therefore, the more a family improves its physical and psychological conditions, the more home-based family involvement progresses increases.

A focus on the following items in the physical environment advances home-based family involvement: they include 1) spending more time working with children (Ascher, 1988; Barker, 1998); 2) making effective use of TV (Barker, 1998; Rich, 1987); 3) supplying reading materials and helping children reach the following goals—a) spend more time in independent reading; b) continue to grow as readers (Barker, 1998; Jones 1988); 4) helping children with their homework (Rich, 1987); 5) supplying a proper place for children to study (Smith, 1968; Rich, 1987; Barker, 1998).

The next factor is the psychological environment of the family. It includes: 1) encouraging the appropriate values and beliefs in family (Barker, 1998; Desimone, 1999)—different beliefs produce different levels of values and belief; 2) developing positive attitudes—proper attitudes which will influence the climate of the family. Positive climate contributes to success in the world because it gives the child a reservoir of self-confidence or "ego strength" that is an important foundation for competence (Garbarino, 1993); 3) rearing patterns of children interaction—a family should practice patterns of authoritative child rearing in which the children enjoy the greatest opportunities to develop their competence (Barker, 1998; Garbarino, 1993).

Strengthening Interaction between Family and School

There are several principles and strategies to strengthen interaction between family and school, so that both work together to advance children's learning.

<u>Principles of Family-school Interaction.</u> The principles of school-family interaction include building proper attitudes, perceiving one's own role, knowing what is the need for each other, and learning diligently the requirements. These will be discussed in the following section.

First, family and school need to establish proper attitudes in the process of interaction. The importance of caring about children's education is accepted by all families whatever their background. However, families need to know what the school expects of them and how they might contribute to their child's schooling (Epstein, 1990). The next factor to consider is teachers' (schools) attitudes because positive attitudes will encourage successful family involvement. Rogers (1980) found that teachers should have attitudes of genuineness, respect, and empathy in mutual communication. Hornby's (2000) study traced another important attitude that teachers need to be is hopeful but realistic in their views about children. In addition, he also found that teachers needed to communicate the attitude that nothing is hopeless and that every situation can be improved.

Second, parents and teachers need to know clearly their role in this issue. There are differences between parents and teachers in the process of family involvement, and they are complementary. The role of the family includes: 1) Recipient of information—family have traditionally been on the receiving end of a variety of information from schools. 2) Governance—family should join the governing bodies of schools to influence school development. 3) Helpers—many families are involved in schools as voluntary helpers. 4) Fundraisers—raising money for the school by such means as cake sells and fun runs have long been important roles which families have played in the schools. 5) Experts—a key contribution which most families make to functioning of schools is by providing teachers with valuable information about their children. 6) Co-educators—many families are now involved in projects which cast them in the role of co-educators of their children along with teachers. 7) Clients—since the advent of open enrollment, the roles of family as clients or consumers have come to the fore. 8) Consultants—families are to be consulted about how well the school functions, both by a questionnaire sent to their homes and by the opportunity to attend a meeting with the inspectors (Hornby, 2000; Morgan, 1993). There are ways for teachers to help families take advantage of the things described above. Despite the changes in today's families, parents continue to care about their children and teachers to care about the achievement of their students. Both have more abilities and potential to do a successful job than ever before (Rich, 1987).

Third, families and teachers need to know what each needs from the other. Hornby (2000) in his workshop learned about parents and teachers mutual expectations. Families want the following from teachers:

1. Teachers to consult them more and listen to their points of view
2. A more open/approachable attitude from teachers
3. Teachers to be willing to admit it if they don't know something
4. Teachers to contact them if they suspect their child has a problem of any kind
5. Teachers to treat all children with respect
6. Teachers to make allowances for individual differences between children
7. Teachers to identify and attempt to re-mediate learning difficulties
8. To discuss their children's progress at effective parent-teacher conferences
9. To provide regular detailed reports on their children's progress
10. Teachers to correct class-work and homework regularly
11. Teachers to be involved with parent-teacher associations (PTAs)
12. Teachers to use them more as a resource in the school

Teachers want the following from families:

1. Be open with them about children's special needs or health problems
2. Tell them about any home circumstances which could affect pupils
3. Co-operate in reinforcing school discipline at home

4. Help reinforce the school program at home through such things as supervising homework or listening to children read
5. Teach children what is expected of them at school
6. Have realistic expectations of what their children are capable of doing
7. Attend PTA meetings
8. Attend meetings with teachers to discuss children's progress
9. Read and acknowledge reports and letters sent home
10. Make sure the school has an up-to-date address and phone details in case they need to be contacted during the day
11. Keep children home if they are not well
12. Volunteer to help out in various ways in school

Fourth, it is necessary for families and teachers to become learners of the issues of family involvement. In order to teach parents or family members today, teachers must work with them as adults, as people with their own learning styles. Adults learn differently from children. Making this transition in working with adults is not easy for teachers who have received little or training in this area (Rich, 1987). Epstein (1985) also pointed out that the majority of teachers have had little or no training in working with parents or families. This is a barrier to set up high levels of family involvement. Therefore, there is a necessity for teacher training in this issue. Parent education is important in family involvement because it will help in changing parents or family members' concepts and attitude toward children's education. If we want to practice family education effectively, we need to understand adult learning characteristics. Knowles (1978) identified four learning characteristics relevant to the family-teacher relationship: 1) Self-direction—Adults tend to know what they need to learn; 2) Life experience—Adults expect to use their experiences in addressing problems; 3) Problem centered—Adults learn best around life problems rather than "subjects." Adults want and need practical solutions; 4) Self-evaluation—Adults not only are ready to determine their own goals (self-direction), but they also want feedback on how well they are progressing to meet these goal.

Strategies of Supporting Family Involvement. The results were displayed in following part. First, family involvement requires proper communication (Espinosa, 1995). According to Becker-Klein's (1999) study, family-school communication is positively related to participation in children's education at home. At the same time, school can become more welcoming by lowering cultural barriers, initiating family involvement, and developing and maintaining communication with families (Russell, 1996). Second, teachers need to establish a personal touch that includes personal meetings and home visits (Espinosa, 1995; Hornby, 2000). Third, schools should help teachers persevere in maintaining family involvement and should build administrative support (Espinosa, 1995). Therefore, each schools needs to develop its own policy for family involvement encompassing issues ranging from its philosophy on working with families to the details of how families are to contact teachers when they have a concern (Espinosa, 1995; Hornby, 2000). Fourth, school development activities should focus on family involvement. These activities must address parents or family members' needs and contributions at every level (Espinosa, 1995; Hornby, 2000). Fifth, establish workshops for families and teachers. Workshops are a group of programs that provide support and guidance to families and teachers. Workshops typically are divided into four parts: introduction, lecture presentation, small-group discussion, and summary (Hornby, 2000).

Applying Vygotsky's ZPD Theory

Zone of Proximal Development

Vygotsky's theory emphasized educational development that he defined as what the child could accomplish with the help of adults or capable peers. Therefore, he offered a theory of the zone of proximal development, a hypothetical, dynamic process in which learning and development took place. Precisely speaking, Vygotsky defined two levels of cognitive development. The first was the child's actual developmental level, as determined by his independent problem solving. The second was his level of potential development, as determined by the kind of problem solving the child could do under adult guidance or in collaboration with a more capable peer. The distance between these two points is the zone of proximal development (Craig, 1996; Vygotsky, [1930-1935] 1978).

Children are viewed as building their learning or development, so that a support system is necessary. The support system is called scaffolding in the theory of ZPD, and it allows children to move forward and continue to build new competencies. Moreover, scaffolding is a temporary step in the learning process, often with the help of an expert (Berk, 1995; Callison, 2001). Berk (1995) further pointed out the effective scaffolding has the components of joint problem solving, intersubjectivity, warmth, and responsiveness. The first component of scaffolding is collaborative problem solving activities. It is important that children interact with someone (either adult-child or child-child groupings) and try to reach a goal. Second, intersubjectivity refers to the process through which two participants begin a task with a different understanding and arrive at a shared understanding. Third, warmth and responsiveness concerns the emotional interaction. Children challenge themselves maximally when in collaboration with an adult or capable peer who is pleasantly warm and positively responsive. Berk also maintains that scaffolding can reach the goals of keeping children in ZPD and promoting self-regulation. A major goal of scaffolding is to keep children working on tasks in their ZPD. To achieve this goal: First, structure the task so that children are appropriately challenged. Second, constantly adjust the amount of adult or capable peer of cooperative learning through positive interdependence; face-to-face interaction; adult intervention to the child's current needs and abilities. Another goal of scaffolding is to foster self-regulation by allowing the child to regulate joint activity as much as possible. This requires the adult or capable peer to relinquish control and assistance as soon as the child can work independently.

The functions of the ZPD were revealed through extended studies. For example, Doolittle (1997) researched integration of the ZPD with the instructional strategy of cooperative learning. He found that ZPD provides individual accountability; small-group and interpersonal skills; and group self-evaluation. In addition, Lewis (1997) studied the essence of the ZPD and found that both novice and expert grow and learn in the process.

Applying ZPD in Children's Learning

Vygotsky's original definition of ZPD indicates that assisted performance can occur "under adult guidance or in collaboration with more capable peers" (Berk, 1995). In the following section, adults' guidance and children's collaboration that apply to the theory of the ZPD will be discussed.

Adult-child Discourse—Reciprocal Teaching

The role of education is to provide children with experiences that are in their ZPDs—activities that challenge children but that can be accomplished with sensitive adult guidance. Consequently, adults carry much responsibility for making sure that children's learning is maximized by actively leading them along the developmental pathway (Berk, 1995). The question is what kind of adult-child discourse is best for children's development and learning? There are some Vygotsky-based principles to guide adult-child discourse. These principles go as follows.

First, adults need to be sensitive to the knowledge, abilities, interests, attitudes, and cultural values, conditions, and practices that children bring to learning situation (Boyes, 1993; Jones, 1993; Moreno, 2000; Pellegrini, 1986; Tudge, 1997). For example, Moreno (2000) used a Vygotskian framework to examine whether adults altered their instruction across time and according to the task at hand. He found under everyday conditions, the adults relied primarily on verbal behaviors, such as commands, labeling, directives, and verbal corrections to guide and maneuver children's activity. Under the school task condition, adults relied on nonverbal behaviors, primarily visual cues and physical corrections.

Second, arrange center-based activities that promote interactive problem solving (Bryan, 1996; Jones, 1993; Reynolds, 1996). Vygotsky placed greater emphasis on interaction among children and adults than on the transfer of knowledge from adult to children. In Reynolds's study, he hypothesized that play is an optimal context for young children's learning. The study found that the process of collaboration and assisted learning in children's social pretend play could promote learning.

Third, promote and accept different solutions and strategies (Charnitski, 1999; Harvey, 1998; Jones, 1993). For example, Charnitski in his study used CMC (computer-mediated communication) as a facilitating technology for an integrated fifth-grade mathematics and science curriculum that is consistent with both a Vygotskian approach to learning and the mathematics and science standards. He found it helps adults narrow the gap between current practices and learning materials when Vygotsky's ZPD theory was applied in technologies.

Fourth, encourage children to tackle tasks within their zone of proximal development—that challenges and stretches their current skills (Berk, 1995; Jones, 1993). Berk analyzing Vygotsky's ZPD theory argued that the adults' role is to keep tasks in children's ZPDs rather than instruct children in what they are ready for or giving them tasks for which they have already acquired the necessary mental operations.

Fifth, offer many opportunities for modeling and engaging in higher order thinking (Harvey, 1998; Jones, 1993; Kovac-Cerovic, 1996; Portes, 1994). For example, in Harvey's (1998) study, he found Mindtools (i.e., computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher-order learning), databases, spreadsheets, and computer-mediated communication promote high level thinking skills and support concept development when applied in the context of Vygotsky's ZPD theory.

Sixth, enrich communication: explain to children the purpose of classroom activities and experiences and have children explain and justify their thinking (Jones, 1993; Nassaji, 2000). For example, Nassajie found that negotiated help provided within the learners' ZPD is more effective than help provided randomly and irrespective of the learners' ZPD.

Seventh, use ongoing assessment of children's zones of proximal development to plan and monitor instruction (Jones, 1993; Mclachlan-Smith, 1991). Mclachlan-Smith described an alternative curriculum for early childhood program based on the work of Vygotsky. He found the provision of appropriate materials in the home and school was a way to monitor the work in children's ZPD.

Child—child Discourse—Cooperative Learning

Berk (1995) analyzing Vgotsky's view found the following important principles concerning child-child cooperative learning. First, children spend a great deal of time engaged in cultural activities with peers (age-mates) who could supply the sources of scaffolding. Second, peer conflict could contribute to heightened understanding. Third, Vygotsky did not identify a starting age at which peer collaboration is possible; instead, he believed that new cognitive capacities could be constructed from child-child interaction at all ages. Fourth, Vygotsky emphasized the importance of mixed-age grouping of children, which grants each child access to more knowledgeable companions and permits each child to serve as an expert resource for others. Fifth, peers can lead one another's development forward as long as the help that one child provides is within the other child's ZPD.

There are several studies that support Berk's analysis. For example, Evangelou (1989) in his study investigated the following items: (1) advantages of mixed-age classes; (2) social development in mixed-age groups; (3) cognitive development in mixed-age groups; and (4) implications for early childhood education. According to Vygotsky's theory, mixed-age interaction among young children offers a variety of developmental benefits to all participants. The results of the study support the position that mixed-age group interaction can have unique adaptive, facilitating, and enriching effects on children's development. Slavin (1987) also found that collaborative activity among children promotes growth because children of similar ages are likely to be operating within one another's zones of proximal development, modeling the collaborating group behaviors more advanced than those they could perform as individuals.

In addition, Kermani, (1997) designed a cross-age tutoring program that examined the features and processes of peer interaction from a Vygotskian perspective. The study specifically focused on the following issues: characteristics of the tutor and tutee that are most likely to enhance learning; types of learning outcomes most amenable to cross-age tutoring; relationship between the task difficulty and the nature and quality of interactions between peers; and teaching strategies used by tutors during their scaffolding process. Ten cross-age peers from kindergarten to fifth grade were paired. Meeting once each week for an hour, each tutorial session consisted of a warm-up activity (crossword puzzle), a major task (concept of measurement, concept of house as living space, two science experiments, and map construction), and an ending activity (card game). Results of in-depth and detailed analysis suggest that older peers can and do assist younger ones thinking in the course of tutoring, but also indicate that there are some limitations to how tutors can successfully scaffold to maximize tutees' learning.

Summary

Reasons Why At-risk Children's Parents (Families) Must Teach Habits of Mind

Although most of us have anxiety in mathematics learning, we still admit that mathematics is an important subject in schooling and our daily life. According to Schwartz's (1987) point of view, mathematics is not only the foundation of every scientific subject, but also supplies greater opportunities to gain employment. She further implied that at-risk children could reform their conditions and environments through receiving proper mathematics education. The purpose of mathematics education is not to gain a lot of mathematical knowledge or produce mathematicians, but to help children acquire higher thinking skills that help children to face future challenges (Cuoco, 1996). Teaching habits of mind supplies an effective way to achieve the above goal. Children can also acquire many benefits from adults and peers who help them acquire habits of mind in mathematics learning.

Family is a microsystem for children's development. The microsystem is the immediate setting in which the child develops. It includes people, objects, and events that occur directly to and with the child (Garbarino, 1993). In this system, there is direct interaction between parents or family members and children. From the perspective of family involvement, this interaction improves children's academic performances, helps children learn proper attitudes and behaviors, and improves their study habits (Ballantine, 1999; Karther, 1997; Sussell, 1996). Therefore, children's habits of mind can be created through this interaction. From this literature review, we found that at-risk children have the following characteristics: low academic achievement, and they test poorly in mathematics (Donnelly, 1987; Green, 1995; Howerton, 1994). This implies at-risk children's parents or family members may play a more important role in educating children's habits of mind. However, at-risk children's parents or family members also have their own risks. This would be another topic to discuss.

From the perspective of Vygotsky's ZPD theory, there is a theoretical rationale to demonstrate that parents or family members are the best educators in teaching habits of mind. Habits of mind are a group of dispositions that are observable and teachable behaviors. According to ZPD theory, children learn habits of mind under adult or capable peer and sibling guidance. Its rationale is that children gain the necessary scaffold or support system from parents-children collaboration that allows the child to move forward and continue to build new habits of mind.

Peers and older siblings can support and help to develop children's habits of mind. In ZPD theory, Vygotsky emphasized the function of collaboration with a more capable peer. He also underlined the importance of the mixed-age grouping of children, which grants each child access to more knowledgeable companions and permits each child to serve as an expert resource for others. Several researches have demonstrated this theory. For example, Kermani, (1997) and two elementary teachers designed a cross-age tutoring program. He found that older peers can and do assist younger ones in thinking in the course of tutoring. These research results can be extended to other learning areas (habits of mind) and people (older sibling). However, the use of older siblings in a supporting role is closely related to parents and teachers guidance.

Reasons Why At-risk Children's Parents (Families) Can Teach Habits of Mind

According to literature reviews, at-risk children's families often have the following background: low socioeconomic status, low educational backgrounds, and minimal educational expectations for their children; low family involvement (Bauer 2001; Donnelly, 1987;). However, we believe that these parents or family members can teach habits of mind in their children's math learning. The reasons will be discussed in following section.

One of the purposes in this study is to supply another effective way for families who do not have mathematical abilities to help their children learn. I will discuss some strategies to clarify what these families can do. First, establish workshops for families. Teachers can teach families to know what the habits of mind are, and show them how to teach these habits of mind at home. Families should be encouraged to join the workshop (Hornby, 2000).

Second, families need to change the physical environment at home. The physical environment includes: 1) spending time working with their children; 2) making effective use of TV; 3) supplying reading materials; 4) helping to accomplish homework and check them; and 5) supplying a proper place for children to study. These elements of physical environment help build gradually children's habits of mind. For example, parents prepare a proper and regular place for children's study. In such a place, children might learn the habit of keeping focus and staying on task.

Third, families need to change the psychological environment at home. This includes: 1) family's values and beliefs 2) family's attitudes; and 3) patterns of interaction. These environments also help build up children's habits of mind. For example, if parents are willing to strive over time and persist in spite of difficulties and set backs to teach their children to learn the habit of perseverance and self-discipline.

In addition, the methods of Vygotsky's ZPD theory also provide guidance to families in building children's habits of mind in math learning. For example, Joint problem solving—one of the components in scaffolding—engages of children in an interesting and culturally meaningful, collaborative problem solving activity. Families can use this component to build up children's habit of cooperating and collaborating.

In sum, According to the strategies of family involvement and the perspective of Vygotsky's ZPD theory, we affirm that the family can teach habits of mind in mathematics learning.

CHAPTER 3

METHODOLOGY

Participants

This study selected two schools located in the Native Taiwanese area. Thirty-one third or fourth grade children along with their siblings or peers (fifth or sixth grade) were selected in each school. These participants were selected randomly as an experimental group that received the workshops and a control group that was not in the workshops (table3-1). The researcher contacted the Principals of these schools to get approval for conducting the study, and they agreed to provide the necessary help to perform this study. The schools provided the list of the names and backgrounds of third through sixth grade, so that subjects and siblings could be matched. A packet of materials, including a brief description of study and an informed consent form were sent to parents through the children.

Table 3.1: Numbers of Participants

School Name	Experiment group		Control group		Total
	Subjects	Siblings	Subjects	Siblings	
Jeso	16	16	15	15	62
Sangmin	15	15	16	16	62
Total	31	31	31	32	124

Contacts with the students were made through their PE, health, or integrated class. Consistent with this study, participants (subjects) were asked to answer and write down their ideas on the worksheets. Siblings whose sisters/brothers were in the experimental group were asked to join the workshops. The contents of the workshops included introducing four habits of mind in math (patterning, experimenting, describing, and visualizing) and the principles of interaction (joint problem solving, intersubjectivity, warmth, and responsiveness). These siblings were taught the skills to help subjects (their young sisters/brothers) learn habits of mind in math.

Parents who agreed to allow their children to participate in the experiment were requested to sign the consent form and return it to the researcher. After getting the parents' consent for participation in the study, every subject was assigned to the pretest, workshops, and posttest.

Instruments

This research measured subjects' habits of mind in math with a pretest and posttest. The following instruments were used to measure the variables used in the present study and to collect the relevant data.

Worksheets

The habits of mind of math include: patterning, experimenting, describing, visualizing. In order to identify the subjects' progress in habits of mind and to determine the effectiveness of sibling workshops, both pretest and posttest were used to assess the progress of subjects' habits of mind in math. All assessment instruments used an open math question format created by the researcher. Every question was designed to be able to show one or more habits of mind in math.

The Worksheet for Sibling Workshops

In order to understand the influences of sibling involvement on subjects' habits of mind, the participants were grouped as experimental and control groups. The siblings who were in the experimental group received information and direction through the workshops, and the control group did not. Appendix C is a copy of the worksheet for sibling workshops.

The Observed Form for Videotapes

Appendix D is a copy of the observational form for the videotapes. The researcher videotaped the subjects as they did their pretest and posttest. The form and videotape allowed the researcher to obtain information about subjects' habits of mind in math.

The Measure for Showing the Scores of Habits of Mind

Cuoco (1996) argued that habits of mind in mathematics student should have six aspects. In this study, the research chose the following items because they were observable. They are *patterning* (finding hidden patterns in the context of mathematics), *experimenting* (when faced with a mathematical problem, we should immediately start playing with it), *describing* (we should be able to do things like: give precise descriptions of the steps in a process), *visualizing* (visualizing data, visualizing relationship). The measures of the habits of mind of math are based on the performances recorded on worksheets. Every habit is coded on a 4-point scale, from 4 = expert, 3 = practitioner, 2 = apprentice, 1 = novice. The form is displayed in Appendix E.

Procedures

This study was conducted in four separate sessions for each school during the research process. Before the actual study, four students from each school took approximately one hour to complete the worksheets for the pilot test and the whole process was videotaped. The contents of the observation forms and worksheets were examined and revised by the researcher after the pilot test. The final procedures and paper forms were created through the above processes.

Through their PE, health, or integrated class, consent forms were sent home to each student wishing to participate. Once the consent forms were returned, a pretest was conducted to give the subjects opportunity to finish worksheets and to gather background data. The purpose of pretest was to understand participants' dispositions about habits of mind in math (patterning, experimenting, describing, and visualizing). The subjects engaged in mathematical problems worksheets by themselves with the researcher's supervision, if they had any questions about understanding the statements in worksheets, the questions were clarified by the researcher. There were 8 subgroups in the pretest, and 8 subjects and two supervisors in every subgroup, so that subjects could get proper help. In addition, every subgroup was recorded by video camera. Every subgroup took approximately one hour to complete the worksheet.

In this study, the siblings who were in the experimental group received information and direction they could use to help their brothers/sisters build up habits of mind through the workshops, and the control group did not. There were four workshops corresponding to habits of mind during the month for the experimental group in each school. Every workshop was divided into four parts: introduction, lecture presentation, small-group practice and discussion, and summary. The total time used was approximately one hour. Four workshops were designed to teach the four habits of mind.

At the end of this study, the same procedure was repeated. The posttest consisted of the same patterns on items and evaluating categories that were used for pretest. In the posttest, every subject had a sibling working with him/her, so he/she could get help from his /her sibling.

In order to measure the result of pretest and posttest for this research, the worksheets and observing forms were translated into quantitative scores for data collection analysis (Appendix E). Each test had fourteen scores for analyzing patterning, experimenting, describing, and visualizing.

The whole procedures of this study were displayed on the table 3-2.

Statistical Analysis

Statistical tests were employed to analyze the data collected in this research. The independent sample *t*-test statistic was selected to test if there were significant differences between control group and experimental group on the pretest. The multivariate analysis of covariance was used for the analysis of the results of the posttest to determine if there were significant differences between control group and experimental group. The reasons for using multivariate analysis of covariance were that the method could test the null hypothesis about the effects of factor variables on the joint distribution of dependent variables and could investigate interaction between factors as well as the effects of individual factors. The pretest scores were used as covariance in the analysis.

Table 3.2: Procedures of the Study

Research States Research Contents	Pilot test	Pretest	Workshops	Posttest	Integrate analysis
Participants	N = 8 4 did pretest worksheets 4 did posttest worksheets	N = 62 Control group = 31 Experimental group = 31 Every participant did worksheets	N = 31 Experimental Group Sibling: Participated in workshops classes	N = 124 Experimental group (Subjects: 31, Siblings: 31): Control group (Subjects: 31, Siblings: 31).	
Researcher and procedures	N = 2 Conducted procedures. Videotaped. Collected data, Analyzed data. Corrected worksheets and research forms. Made formal worksheets	N = 2 Sent and collected consents. Grouped. Conducted procedures. Videotaped, Collected data. Analyzed data	N = 2 Conducted classes. Videotaped	N = 2 Conducted procedures, Videotaped. Collected data. Analyzed data	Compared: $C_{pretest}$ and $E_{pretest}$ $C_{posttest}$ and $E_{posttest}$ *C = control group *E = experimental group
Tools and instruments	Pencils. color pencils, rules, calculators, watch, video cameras, worksheets.	Consents. Pencils. color pencils. rules, calculators. watch. video cameras. worksheets. observing forms. field-notes forms. measure forms.	Courses outlines. activities designing sheets. video cameras	Pencils. color pencils. rules. calculators. watch. video cameras. worksheets. observing forms. field-notes forms. measure forms.	Windows SPSS

CHAPTER 4

RESULTS

Introduction

This chapter is reports the results of the research. First, the process and results of the pilot test are provided. In the pilot test, the procedures and the contents of the worksheets of the pretest and posttest were examined. Second, all subjects were placed in different groups and finished worksheets. The results of subjects' habits of mind in math were assessed in the pretest. In this section, the details of testing processes are described. Third, the summary of the results from workshops is provided. The research included four workshops for each school. Siblings whose brothers/sisters were in the experimental group participated in these workshops. Fourth, every subject joined posttest with their siblings after workshops. Subjects' habits of mind in math were displayed by checking the worksheets that subjects completed. The remainder in every part is devoted to an analysis of data to determine if the research hypotheses are accepted or rejected.

Pilot Test

The purpose of the pilot test was to operationalize habits of mind. One of the difficulties in researching habits of mind is that these habits appear to be nebulous. It was imperative to redefine habits of mind so that they could be taught. This redefinition had to be linked with ways of measuring the habits. The habits of mind identified were:

pattering, experimenting, describing, and visualizing. In the pilot test, 8 participants were selected from Jeso and Shanmin Elementary School. Four of them responded to pretest worksheets and the others did posttest worksheets (table4-1).

Table 4.1: Numbers of Participants in the Pilot Test

School	Worksheet Types	Numbers
Jeso	Pretest	n = 2
	Posttest	n = 2
Shainmin	Pretest	n = 2
	Posttest	n = 2

The pilot test proceeded according to the pilot test schedule (table 4-2). First, the participants were selected and necessary instruments or tools were prepared. Second, several meeting were conducted before and after pilot test. In these meetings, the processes and the contents of worksheets were examined by the researcher and two assistants. Third, participants were interviewed for whether the worksheets items were appropriate or not. Fourth, each participant's behaviors videotaped were reviewed by the researcher in order to observe participant's responses.

Table 4.2: Schedule for the Pilot Test

Date	Items	Conductor	Notes
12/20	Determining participants and dates	R*	
12/21-22	Preparing instruments and tools for pilot test	R*	Pencils, color pencils, rules, calculators, watch, video cameras, worksheets.
12/23	Planning meeting	R*, AA*, BA*	
12/24	Pilot test at Shanmin, meeting, putting worksheets in order	R*, AA*	
12/25	Pilot test at Jeso, meeting, putting worksheets in order	R*, BA*	
12/26	Interviewing at Shanmain, Analyzing Data	R*, AA*	
12/27	Interviewing at Jaso, Analyzing Data	R*, BA*	
12/28	Correcting worksheets	R*, BA*	
12/29	Determining formal worksheet of the pretest and posttest, observing forms	R*	

PS: R* = Research, AA* = A Assistant, BA*= B Assistant

The researcher confirmed the experimental procedures in the pilot test, using the contents of worksheets and the observations. Moreover the researcher also developed forms for observing and recording. Firstly, the procedures of pretest and posttest were: 1) Introduction: The researcher revealed the purpose and processes of the tests in this section; 2) Operation: There were four worksheets for participants in each test. Participants had to finish their work step by step. If they had any questions, they might ask the researcher; 3) Final arrangement: every participant's work was examined according to the study steps, so that their works could be analyzed.

Second, the researcher corrected worksheets as a result of the interviews and meeting. They included: 1) Deleting confusing items: The researcher deleted some items because they did not probe the habits that the research wanted, or they left participants confused. All the details were illustrated by table 4-3 and table 4-4; 2) Items were numbered: It was difficult to translate the results of the test to the record form because the items that were in the worksheets were not numbered. The researcher revised the worksheets; 3) Designing the printed pages: The number of worksheets in the pilot test were too many; moreover, the size of the font also too big. Therefore, it was necessary to rearrange the printed pages. The final printed pages were displayed on Appendix A and Appendix B.

Table 4.3: Original Items and Revised Items in the Pilot Test for the Pretest

Original items	Revisal items and illustrations
Worksheet 1 ： Making a hundreds chart	
I. Please answer the following questions before making a hundreds chart. 1. Have you ever made a hundreds chart (Please check "×" in☐)? ☐ NO; ☐ Yes (if you chose "no", jump to item 3) 2. If you have ever made a hundreds chart, would you make it using the previous way? ☐ I would; why? ☐ I won't; why? 3. How do you make your hundreds chart, write down your opinions?	*Deleted "I" items and made a new item with a number.* I. We need to make a hundreds chart before you start the worksheets. Please write down your opinions or plan about how to make it. 1-1
II. Please make a hundreds chart in the reverse side of this sheet then write the numbers 1 to 100 into the chart orderly.	*Kept item "II" and gave a number* "1-2"
Worksheet 2: Magic calculator	
There are two activities in the following section. You need a calculator to do them. Please finish it according to the direction and record the results	*Keep this illustration.*
Part I:	Number 2-1
A. Use a calculator and follow along the steps Press "ON/AC" key Press "0 +2" = = = (keep pressing the "=" key) until you find 100	Number 2-1-1
B. Color green each number that show on the display	*Revise the item as* "Color green each number on the display in hundreds chart" *and number as 2-1-2.*
C. What do you want to find out from the chart that you colored with green?	*Highlight the words in item as*: "**What do you want** to find out from the chart that you colored with green?" *and number as 2-1-3.*
D. Please observe your chart, especially the green parts. Write down every thing you find.	*Number as 2-1-4.*
Part II:	*Number as 2-2.*

Continued, next page

Table 4.3, continued

<table>
<tr><td>A. Use a calculator and follow along the steps
Press "ON/AC" key
Press "0 +5" = = = (keep pressing the "=" key) until you find 100
B. Color yellow each number that show on the display

C. What do you want to find from the chart that you colored with yellow?

D. Please observe your chart, especially the yellow parts. Write down every thing you find.</td><td>Number as 2-2-1.
Continued, next page
Revise the item as "Col(the display in hundreds chart" and number as 2-2-2.
Highlight the words in item as: "What do you want to find out from the chart that you colored with yellow?" and number as 2-2-3.

Number as 2-2-4.</td></tr>
<tr><td colspan="2">Worksheets III: Finding information from tables</td></tr>
<tr><td>I. Please find six even number in hundreds chart.
II. Observe the following table carefully and answer the questions
What is the column? (   )
What is the column? (   )
<table>
<tr><td></td><td></td></tr>
<tr><td>1. Mary</td><td>75, 80, 85, 90, ____</td></tr>
<tr><td>2. John</td><td>75, 85, 95, 105, ____</td></tr>
<tr><td>3.David</td><td>12, 14, 16, 18, _____</td></tr>
<tr><td>4.Tom</td><td>73, 75, 77, 79, _____</td></tr>
<tr><td>5.Jean</td><td>73, 173, 273, 373, ____</td></tr>
<tr><td>6.Luke</td><td>150, 152, 154, 156, ___</td></tr>
<tr><td>7.Lidia</td><td>115, 120, 125, 130, ___</td></tr>
<tr><td>8.Judy</td><td>56, 66, 76, 86, ____</td></tr>
</table>

III. Look at the table above and find the people whose number are "skip-count by 2s".

A. Answer: ______________________________
B. Find and write down the same and different statements between your choices.
IV. Please find six numbers that skip-count by 5s in hundreds</td><td>Delete "I" because of its non-effective.
Change number title "II" as "I" and number as 3-1

Change number title "III" as "II", change the words "skip-count by 2s" as "even number", and number as 3-2
Number as 3-2-1
Number as 3-2-2

Change number title "IV" as "III" and number as 3-3</td></tr>
</table>

Continued, next page

chart. V. Look at the table above and find the people who number are "skip-count by 5s". A. Answer: ______________________ B. Find and write down the same and different statements between your choices.	*Change number title "V" as "IV" and number as 3-4* Number as 3-4-1 Number as 3-4-2
Worksheets IV: Making a Table	
Please make a table according to the statement that people and number were matched. 1. Mary A. 75,80,85,90, 2. John B. 75,85,95,105, 3.David C.12,14,16,18, 4.Tom D.73,75,77,79, 5.Jean E.73,173,273,373, 6.Luke F.150,152,154,156, 7.Lidia G.115,120,125,130, 8.Judy H.56,66,76,86,	
I. Observe the tables below. Which table you will choose? 1. ☐ A table; ☐ B table. 2. Why? II. According to your choice, put the names and numbers in the tables.	Numbered as 4-1 Numbered as 4-1-1 Numbered as 4-1-2 Numbered as 4-2

A table

B table

Continued, next page

Table 4.3, continued

III. Look at Judy's numbers and answer the questions.	Numbered as 4-3
A. Fill out a serial numbers: 150, 152, 154, 156, __, __, __, __	Numbered as 4-3-1
B. Why do you write down these numbers?	Numbered as 4-3-2
IV. Look at Luke's numbers and answer the questions.	Numbered as 4-4
A. Fill out a serial numbers: 115, 120, 125, 130, __, __, __, __	Numbered as 4-4-1
B. Why do you write down these numbers?	Numbered as 4-4-2

Table 4.4: Original Items and Revised Items in the Pilot Test for the Posttest

Original items	Revised items
Worksheets I: Making hundred chart	
I. Please answer the following questions before making a hundreds chart. 1. Have you ever made a hundreds chart (Please check "×" in☐)? ☐ NO; ☐ Yes (if you chose "no", jump to item 3) 2. If you have ever made a hundreds chart, would you make it using the previous way? ☐ I would: why? ☐ I won't; why? 3. How do you make your hundreds chart, write down your opinions?	*Deleted "I" items and made a new item with a number.* I. We need to make a hundreds chart before you start the worksheets. Please write down your opinions or plan about how to make it. 1-1
II. Please make a hundreds chard in the reverse side of this sheet then write the numbers 1 to 100 into the chart orderly.	*Kept item "II" and gave a number* "1-2"
Worksheet 2: Magic calculator	
Part I:	Number 2-1
A. Use a calculator and follow along the steps Press "ON/AC" key Press "0 + 1 +2" = = (keep pressing the "=" key) until you find 99	Number 2-1-1
B. Color green each number that show on the display	*Revise the item as* "Color green each number that on the display in hundreds chart" *and number as 2-1-2.*
C. What do you want to find out from the chart that you colored with green?	*Highlight the words in item as*: "**What do you want** to find out from the chart that you colored with green?" *and number as 2-1-3.*
D. Please observe your chart, especially the green parts. Write down every thing you find.	*Number as 2-1-4.*
Part II:	*Number as 2-2.*
A. Use a calculator and follow along the steps Press "ON/AC" key Press "0 +10" = = = (keep pressing the "=" key)	*Number as 2-2-1.*

Continued, next page

Table 4.4, continued

<table>
<tr><td>until you find 100
B. Color yellow each number that show on the display
C. What do you want to find from the chart that you colored with yellow?
D. Please observe your chart, especially the yellow parts. Write down every thing you find.</td><td>
Revise the item as "Color yellow each number that on the display in hundreds chart" and number as 2-2-2.
Highlight the words in item as: "What do you want to find out from the chart that you colored with yellow?" and number as 2-2-3.
Number as 2-2-4.</td></tr>
<tr><td colspan="2">Worksheets III: Finding information from tables</td></tr>
<tr><td>I. Please find six odd number in hundreds chart.
II. Observe the following table carefully and answer the questions
What is the column? (   )
<table>
<tr><td></td><td></td></tr>
<tr><td>1. Mary</td><td>75, 80, 85, 90, ____</td></tr>
<tr><td>2. John</td><td>75, 85, 95, 105, ____</td></tr>
<tr><td>3.David</td><td>12, 14, 16, 18, _____</td></tr>
<tr><td>4.Tom</td><td>73, 75, 77, 79, _____</td></tr>
<tr><td>5.Jean</td><td>73, 173, 273, 373, ___</td></tr>
<tr><td>6.Luke</td><td>150, 152, 154, 156, ___</td></tr>
<tr><td>7.Lidia</td><td>115, 120, 125, 130, ___</td></tr>
<tr><td>8.Judy</td><td>56, 66, 76, 86, ____</td></tr>
</table>
What is the column?
(   )

III. Look at the table above and find the people whose numbers are "odd".
A. Answer: ______________________
B. Find and write down the same and different statements between your choices.
IV. Please find six numbers that skip-count by 10s in hundreds chart.
V. Look at the table above and find the people who number are "skip-count by 10s".
A. Answer: ______________________</td><td>Delete "I" because of its non-effective.
Change number title "II" as "I" and number as 3-1

Change number title "III" as "II" and number as 3-2

Number as 3-2-1
Number as 3-2-2

Delete this item

Revised items IV. Look at Judy's number carefully from the table. 3-4
A. What do you want to find when you look at Judy's</td></tr>
</table>

Continued, next page

Table 4.4, continued

B. Find and write down the same and different statements between your choices.	number? *3-4-1* B. What do you find from Judy's numbers (please write down your steps and results in details)? *3-4-2* C. Whose characteristics of numbers are same as Judy? *3-4-3*
Worksheets IV: Making a Table	
Please categorize these numbers bellow and table or graph it. 16, 34, 58, 65, 93, 39, 71, 27, 62, 148。 A. Write down your steps that finish this figure. B. Write down the results that you categorized. C. What are the reasons that you categorized them? D. Display your figure in a space.	Keep this illustration *Rewrite the items and number every item.* A. How do you categorize these numbers? Please write down your steps and results. *4-1* B. How do you make your table? Please write down your steps. *4-2* C. Display your table or graph in a space. *4-3*

Third, the observations were scored as follows: 1) Response time: we observed and recorded time required to respond to the items. 2) Concentration: Participant's frequency in glancing right and left, improper posture, or other actions observed and recorded. 3) Fluency: Participant's using systematic steps were defined as the fluency. This element also was observed and recorded. The researcher videotaped the whole process, so that we would observe and record every thing we wanted. The "*experimenting*", habits of mind in math, were constructed out of three elements. In table 4-5, displays the whole contents concerning of the observation.

Table 4.5: Record Form for Videotape (Observation of Experimenting)

Time of responding to item	**Under 5 seconds**	**5 to 10 seconds**	**11 to 15 seconds**	**Over 16 seconds**
Concentration	**Glancing right and left**	**Improper posture**	**Leafing over paper**	**Other actions**
Fluency in processes	**Very fluent**	**Fluent**	**Still fluent**	**Not fluent**

Finally, the measuring instrument needed to be revised because many observational items or contents were changed after pilot test. The directions for revising this form were done according to the following principles: 1) Keeping the original indicators; 2) Keeping the scoring system; 3) Simplifying and behaviorally defining; 4) Responding to the result of the pilot test. In table 4-6, researcher displayed the comparison between original and revised measuring form. The final printed pages were displayed on Appendix E.

Table 4.6: Comparison between Original and Revising Measuring Form

Indicators	Scoring	Original contents	Revised contents
Patterning	Expert (4)	Children Fall into the habit of looking for patterns when they are given problems by someone else Finding hidden patterns in the context of mathematics	1.Subject searches 3 times for pattern when solving a math problem. 2.Subjects can find patterns in the context of math and analyze the characteristics of pattern completely and accurately
	Practitioner (3)	Finding hidden patterns in the context of mathematics	1. Subject searches 2 times for pattern when solving a math problem.. 2.Subjects can find patterns in the context of math and analyze the characteristics of pattern completely.
	Apprentice (2)	Children try to look for patterns when they are given problems by someone else, but gives up when they can not find	1. Subject searches 1 times for pattern when solving a math problem. 2.Subjects can find patterns in the context of math, but can't analyze the characteristics of pattern.
	Novice (1)	Children give up trying looking for patterns when they are given problems by someone else	1. Subject does not search for pattern when solving a math problem. 2.Subjects can't find patterns in the context of math and analyze the characteristics of pattern.
Experimenting	Expert (4)	1.When faced with a mathematical problem, children start immediately playing with it. 2.When faced with a mathematical problem, children start immediately using strategies that have proved successful in the past. 3.Children performing through experiments	1.Subject responds problems under 5 seconds. 2.Subject is very concentrative in the process of resolving problems (under 5 times). 3.The processes are very fluent in subject's works.

Continued, next page

Table 4.6, continued

	Practitioner (3)	1. When faced with a mathematical problem, children start immediately playing with it. 2. When faced with a mathematical problem, children start immediately using strategies that have proved successful in the past.	1.Subject responds problems from 5 to 10 seconds. 2.Subject is concentrative in the process of resolving problems (under 5 times). 3.The processes are fluent in subject's works.
	Apprentice (2)	When faced with a mathematical problem, children start immediately using strategies that have proved successful in the past.	1.Subject responds problems from 11 to 15 seconds. 2.Subject is less concentrative in the process of resolving problems (11to 15 times). 3.The processes are less fluent in subject's works.
	Novice (1)	When faced with a mathematical problem, children start immediately playing with it.	1.Subject responds problems over 16 seconds. 2.Subject is not concentrative in the process of resolving problems (over 16 times). 3.The processes are not fluent in subject's works.
Describing	Expert (4)	1.Give precise descriptions of the steps in a process 2.Invent notation 3.Write: children write down their thought, results, conjectures, arguments, proofs, questions, and opinions (Having all of them)	1.Subject gives precise and complete descriptions of the steps in a process. 2.Subject writes down his /her thought, results, conjectures, arguments, proofs, questions, and opinions precisely and completely.

Continued, next page

Table 4.6, continued

	Practitioner (3)	1.Give precise descriptions of the steps in a process 2.Invent notation 3.Write: children write down their thought, results, conjectures, arguments, proofs, questions, and opinions (Have two of them)	1.Subject gives complete descriptions of the steps in a process. 2.Subject writes down his /her thought, results, conjectures, arguments, proofs, questions, and opinions completely.
	Apprentice (2)	1.Give precise descriptions of the steps in a process 2.Invent notation 3.Write: children write down their thought, results, conjectures, arguments, proofs, questions, and opinions (Have one of them)	1.Subject gives incomplete descriptions of the steps in a process. 2.Subject writes down his /her thought, results, conjectures, arguments, proofs, questions, and opinions incompletely.
	Novice (1)	1.Give precise descriptions of the steps in a process 2.Invent notation 3.Write: children write down their thought, results, conjectures, arguments, proofs, questions, and opinions (Have zero of them)	1.Subject can't give descriptions of the steps in a process. 2.Subject can't write down his /her thought, results, conjectures, arguments, proofs, questions, and opinions.
Visualizing	Expert (4)	1.Visualizing data 2.Visualizing relationship 3.Visualizing processes 4.Visualizing change 5.Visualizing calculation (Having all of them)	1.Subject constructs precise and complete tables or graphs from descriptions of mathematical problems. 2.Subject finds precise and complete clues that can resolve mathematical problems from the tables or graphs.

Continued, next page

Table 4.6, continued

	Practitioner (3)	1. Visualizing data 2. Visualizing relationship 3. Visualizing processes 4. Visualizing change 5. Visualizing calculation (Having 3-4 of them)	1.Subject constructs complete tables or graphs from descriptions of mathematical problems. 2.Subject finds complete clues that can resolve mathematical problems from the tables or graphs, but not precise.
	Apprentice (2)	1. Visualizing data 2. Visualizing relationship 3. Visualizing processes 4. Visualizing change 5. Visualizing calculation (Having 2 of them)	1.Subject constructs imprecise and incomplete tables or graphs from descriptions of mathematical problems. 2.Subject finds precise and complete clues that can resolve mathematical problems from the tables or graphs, but not precise and complete.
	Novice (1)	1. Visualizing data 2. Visualizing relationship 3. Visualizing processes 4. Visualizing change 5. Visualizing calculation (Having 1 of them)	1.Subject can't construct tables or graphs from descriptions of mathematical problems. 2.Subject can't find clues that can resolve mathematical problems from the tables or graphs.

Pretest

In this section a description of the procedures and results for the pretest are presented. First, demographic characteristics of the participants are described. Second, detailed procedures and instruments also are displayed. The statistical findings and results will be showed in the final part.

In the pretest, sixty-two students participated in the study and were divided into two groups—control group and experimental group. Students in this study were females 34 (55%) and males 28 (45%); 39% of the students were third grade (n = 24) and 61 % of students were fourth grade (n = 38). Participants in the control group, females were 16

(52%) and males were 15 (48%); 32% of students were third grade (n = 10) and 68% of students were fourth grade (n = 21). In the experimental group, there were females 18 (58%) and males 13 (42%); 45% of students were third grade (n = 14) and 55% of students were fourth grade (n = 17).

Table 4.7: Gender and Grade of Students in the Control and Experimental Groups

Items		Control group	Experimental group	Total
Gender				
Female	n	16	18	34
	%	***52***	***58***	***55***
Male	n	15	13	28
	%	***48***	***42***	***45***
Total		31	31	62
Grade				
3 grade	n	10	14	24
	%	***32***	***45***	***39***
4 grade	n	21	17	38
	%	***68***	***55***	***61***
Total		31	31	62

In order to identify the participants' habits of mind in math, a pretest was used to assess the procedures and results using participants' worksheets. First, each group was divided into four subgroups, and every subgroup had seven or eight participants with two supervisors, so that participant could be supervised in the processes of test. Every participant did the same worksheets. The researcher spent two weeks conducting the test (table 4-8).

Table 4.8: Pretest Schedule

Groups	Total number	Subgroup	Number	Supervisor	Date
Control group	N = 31	A group	n = 8	R* & AA*	2/2/04
		B group	n = 8	R* & AA*	2/3/04
		C group	n = 8	R* & AB*	2/9/04
		D group	n = 7	R* & AB*	2/10/04
Experimental group	N = 31	E group	n = 8	R* & AA*	2/4/04
		F group	n = 8	R* & AA*	2/5/04
		G group	n = 8	R* & AB*	2/11/04
		H group	n = 7	R* & AB*	2/12/04

PS: R* = Research, AA* = A Assistant, BA*= B Assistant

Second, data collection and management were initiated after participants finished their work. The data came from worksheets, videotapes, and field notes. There were four worksheets, one for each habit of mind for every participant in the pretest. According to the goals of this study, every item in worksheets and observations indicators (behavior) were matched (table 4-9), so researcher could coordinate data that this study required. In other words, if participants responded to every item, the researcher could find their habits of mind through their responses. Sixty-two participants completed the pretest. The researcher filed every participant's worksheets and numbered it. The data on habits of mind included patterning, describing, and visualizing. The procedures were videotaped while each participant was doing his/her worksheets. Every videotape was reviewed and recorded by researcher. "Experimenting", one of the habits, could be identified only by using videotape procedures. The supervisors of the pretest made notes for supplementary data. They included the records of participants' requests, the category of participants' questions, and the figures of participants' seats.

Table 4.9: Worksheet Items Matching Observational Indicators (Pretest)

Worksheets Items	**Observing Indicators**
Worksheet 1 ： Making a hundreds chart	
I. We need to make a hundreds chart before you start the worksheets. Please write down your opinions or plan about how to make it. 1-1	D1: describing procedures
II. Please make a hundreds chart in the reverse side of this sheet then write the numbers 1 to 100 into the chart orderly. 1-2	V1: constructing figures D1: expressing procedures
Worksheet 2: Magic calculator	
There are two activities in the following section. You need a calculator to do them. Please finish it according to the direction and record the results	
Part I: 2-1	
A. Use a calculator and follow along the steps. 2-1-1 Press "ON/AC" key Press "0 +2" = = = (keep pressing the "=" key) until you find 100	D1: following the described steps or procedures
B. Color green each number that show on the display in hundreds chart. 2-1-2	V1: constructing figures
C. What do you want to find out from the chart that you colored with green? 2-1-3	P1: having a habits to look for patterns D2: writing down the results V2: finding clues
D. Please observe your chart, especially the green parts. Write down every thing you find. 2-1-4	P2: finding and analyzing patterns D2: writing down the results D1: writing down the opinions step by step V2: finding clues
Part II: 2-2	
A. Use a calculator and follow along the steps. 2-2-1 Press "ON/AC" key Press "0 +5" = = = (keep pressing the "=" key) until you find 100	D1: following the described steps or procedures
B. Color yellow each number that show on the display in hundreds chart. 2-2-2	V1: constructing figures

Continued, next page

Table 4.9, continued

<table>
<tr><td>C. What do you want to find from the chart that you colored with yellow? 2-2-3</td><td>P1: having a habit to look for patterns
D2: writing down the results
V2: finding clues</td></tr>
<tr><td>D. Please observe your chart, especially the yellow parts. Write down every thing you find. 2-2-4</td><td>P2: finding and analyzing patterns
D2: writing down the results
D1: writing down the opinions step by step
V2: finding clues</td></tr>
<tr><td colspan="2">Worksheets III: Finding information from tables</td></tr>
<tr><td>I. Observe the following table carefully and answer the questions. 3-1
What is the column? (   )
What is the column? (   )
<table>
<tr><td></td><td></td></tr>
<tr><td>1. Mary</td><td>75, 80, 85, 90, ____</td></tr>
<tr><td>2. John</td><td>75, 85, 95, 105, ____</td></tr>
<tr><td>3.David</td><td>12, 14, 16, 18, _____</td></tr>
<tr><td>4.Tom</td><td>73, 75, 77, 79, _____</td></tr>
<tr><td>5.Jean</td><td>73, 173, 273, 373, ____</td></tr>
<tr><td>6.Luke</td><td>150, 152, 154, 156, ___</td></tr>
<tr><td>7.Lidia</td><td>115, 120, 125, 130, ___</td></tr>
<tr><td>8.Judy</td><td>56, 66, 76, 86, ____</td></tr>
</table>
</td><td>V1: constructing figures</td></tr>
<tr><td>II. Look at the table above and find the people who number are "even number". 3-2
A. Answer: ______________________________. 3-2-1
B. Find and write down the same and different statements between your choices. 3-2-2</td><td>P2: finding and analyzing patterns
V2: finding clues from figures
D2: writing down the results
D1: writing down the opinions step by step</td></tr>
<tr><td>III. Look at the table above and find the people who number are "skip-count by 5s". 3-3
A. Answer: ______________________________. 3-3-1
B. Find and write down the same and different statements between your choices. 3-3-2</td><td>P2: finding and analyzing patterns
V2: finding clues from figures
D2: writing down the results
D1: writing down the opinions step by step</td></tr>
</table>

Continued, next page

Table 4.9. continued

Worksheets IV: Making a Table	
Please make a table according to the statement that people and number were matched. 1. Mary A. 75.80.85.90. 2. John B. 75.85.95.105. 3.David C.12.14.16.18. 4.Tom D.73.75.77.79. 5.Jean E.73.173.273.373. 6.Luke F.150.152.154.156. 7.Lidia G.115.120.125.130. 8.Judy H.56.66.76.86.	
I. Observe the tables below. Which table you will choose? 4-1 1. ☐ A table: ☐ B table. 4-1-1 2. Why? 4-1-2	V1: deciding to construct a figure D2: writing down the results D3: writing down the opinions step by step
II. According to your choice, put the names and numbers in the tables. 4-2	V1: constructing figure

A table

B table

Continued, next page

Table 4.9, continued

III. Look at Judy's numbers and answer the questions. 4-3 A. Fill out a serial numbers: 150, 152, 154, 156, __, __, __, __. 4-3-1	P1: having a habit to look for pattern P2: finding and analyzing patterns
B. Why do you write down these numbers? 4-3-2	D1: writing down the opinions step by step D2: writing down the results
IV. Look at Luke's numbers and answer the questions. 4-4 A. Fill out a serial numbers: 115, 120, 125, 130, __, __, __, __. 4-4-1	P1: having a habit to look for pattern P2: finding and analyzing patterns
B. Why do you write down these numbers? 4-4-2	D1: writing down the opinions step by step D2: writing down the results

Third, the data were scored by response time, counting times, and using a weighted mean to decide final level (expert, practitioner, apprentice, and novice). In the worksheets of this study, ten behaviors in the "patterning", twenty in the "describing", and twelve in "visualizing" were observed (table 10). Three categories were observed in the "experimenting"—participants' responses (4 times), concentration (20 times—every 3 minutes being recorded during 1 hour), and fluency (4 times). All of these responses were on a 4 point score—4 (expert), 3 (practitioner), 2 (apprentice), and 1 (novice) through using weighted mean. For example, one of participants scored 4 times as practitioner, 2 times as novice in the "P2" (finding and analyzing patterns). The process of using weighted mean is: 3 (4÷6) + 1(2÷6) = 2.33, and round 2.33 to 2.

Table 4.10: Times of Indicators Being Observed in the Pretest

Indicators / Times	Patterning		Experimenting			Describing		Visualizing	
	P1	P2	E1	E2	E3	D1	D2	V1	V2
Times of sub-indicators	4	6	4	20	4	11	9	6	6
Times of total	10		28			20		12	

The purpose of the statistical analysis is to explore further the significant difference between experimental group and control group in the pretest. The null hypothesis in pretest therefore was " There are no significant difference between experimental group and control group in the habits of mind in mathematics." The value of t_{crit} (0.05) is 2.01; and the t-test criterion is: accept the null hypothesis if $t \leq 2.01$ or reject the null hypothesis if $t \geq 2.01$. When calculating the value of t, we obtained $t = -0.115$ (table 4-11). A glance at 4-11 indicates that there are no significant difference on any tests between the experimental and control groups.

Table 4.11: Results of t Test in the Pretest

		Levene's Test for Equality of Variancces		t-test		
		F	Sig.	t	df	Sig.
Total	Equal variances assumed	2.750	.102	-.115	60	.909
	Equal variances not assumed			-.115	58.052	
P	Equal variances assumed	1.330	.253	-.413	60	.681
	Equal variances not assumed			-.413	59.077	
P1	Equal variances assumed	9.547	.003	-1.438	60	.156
	Equal variances not assumed			-1.438	30.000	
P2	Equal variances assumed	1.623	.208	.000	60	1.000
	Equal variances not assumed			.000	58.001	
E	Equal variances assumed	1.761	.190	.469	60	.641
	Equal variances not assumed			.469	58.318	
E1	Equal variances assumed	.236	.629	-.181	60	.857
	Equal variances not assumed			-.181	59.725	
E2	Equal variances assumed	.059	.808	.523	60	.603
	Equal variances not assumed			.523	59.730	
E3	Equal variances assumed	1.738	.192	.870	60	.388
	Equal variances not assumed			.870	56.492	
D	Equal variances assumed	.241	.625	-.133	60	.895
	Equal variances not assumed			-.133	59.838	
D1	Equal variances assumed	.273	.604	.212	60	.833
	Equal variances not assumed			.212	59.484	
D2	Equal variances assumed	.264	.609	-.477	60	.635
	Equal variances not assumed			-.477	59.424	
V	Equal variances assumed	1.946	.168	-.462	60	.646
	Equal variances not assumed			-.462	58.101	
V1	Equal variances assumed	.294	.590	.271	60	.787
	Equal variances not assumed			.271	59.948	
V2	Equal variances assumed	1.536	.220	-.776	60	.441
	Equal variances not assumed			-.776	57.819	

Workshops

In order to understand the influences of sibling involvement on subjects' habits of mind, workshops were used in this study. The siblings of the experimental group were taught how to use habits of mind to resolve mathematical problems. Planning for the workshops included curriculum plans, worksheets, schedules, and evaluating forms. The scores of the participants placed them on different levels of habits of mind in math. The results are displayed in the final part of this section.

Schedule and content

The participants of the workshop were placed in two sub-groups. Each sub-group had fifteen or sixteen siblings and two supervisors. There were four workshops, one for each habits of mind during the month for each sub-group. Every workshop was divided into four parts: introduction, lecture presentation, small-group practice and discussion, and summary. The total time used was approximately one hour. The contents of workshops included the four aspects (patterning, experimenting, describing, and visualizing) that were included to this study. In addition, the interaction skills—joint problem solving, intersubjectivity, warmth, and responsiveness also were emphasized with the contents of classes (table 4-12). Contacts with the participants were made through after school on the Wednesdays or Fridays of March.

Table 4.12: Schedule and Contents of the Workshops

Date	Contents	Schedules
Group1: 3/3/04 Group2: 3/5/04	A. Habits of mind: patterning B. Joint problem solving	14:00-14:05 Introduction 14:05-14:20 Lecture presentation 14:20-14:50 Activities and performance 14:50-15:00 Summary
Group1: 3/10/04 Group2: 3/12/04	A. Habits of mind: describing. B. Intersubjectivity	14:00-14:05 Introduction 14:05-14:20 Lecture presentation 14:20-14:50 Activities and performance 14:50-15:00 Summary
Group1: 3/17/04 Group2: 3/19/04	A. Habits of mind: visualizing. B. Warmth	14:00-14:05 Introduction 14:05-14:20 Lecture presentation 14:20-14:50 Activities and performance 14:50-15:00 Summary
Group1: 3/17/04 Group2: 3/19/04	A. Habits of mind: experimenting B. Responsiveness	14:00-14:05 Introduction 14:05-14:20 Lecture presentation 14:20-14:50 Activities and performance 14:50-15:00 Summary

Plans for the workshop

The purpose of the workshop was to teach siblings whose brothers or sisters were in the experimental group the habits of mind in math. Therefore, the designs of the activities focused on how to improve these siblings' habits. First, the researcher operationalized the indicators as observable and practicable behaviors. For example, the habit of mind of "patterning" was interpreted as two behavior goals—"having a habits to find patterns" and "being able to find and analyze patterns". Second, reduce participants' anxiety by using simple mathematics. Generally speaking, at-risk children have higher anxiety than others in learning math. The researcher, therefore, designed simple and easily understood items for them. For example, the research asked participants find the pattern for these numbers—"7, 81, 302, 463, 56, 4, 25, 288, 70, 109." Third, prefer performance to lecture. In this plan, the researcher made many performance activities. The supervisors revealed the principle of solving the problems. In addition, the researcher also supplied some extra items for practice, so that the participants could be proficient in these behaviors. Fourth, understanding what they learn through discussion was important. The researcher supplied many activities for discussion, so that they could clarify the habits that they needed to learn from the workshop. For example, there was an activity that participants watched TV to observe a student's behaviors in an experiment. After watching the videotape, there was much discussion about how to help their brothers/sisters responding, concentrating, and being fluent in their works. The plan was displayed in table 4-13.

Table 4.13: Activities for Workshops

The goals of behaviors
P1: Having a habit to find out patterns P2: Being able to find and analyze patterns D1: Describing the procedures precisely and completely D2: Writing down the results precisely and completely V1: Constructing the figures precisely and completely V2: Finding the clues precisely and completely from giving problems E1: Operating the work immediately when facing the problems E2: Being able to concentrate in the processes E3: Having fluency in the processes

Activities	Illustrations	Notes
Activity I: Finding Pattern		
A. Discussion: What would you think when you face a math problem?	* Participants could give any answer and supervisor write down them on the board	P1
B. B. Reveal problem: □ ○ ◇ □ ○ ____	* The principle for analysis 1. Finding patterns from information that we already knew. 2. Making inference and decision from the patterns	P2
	* The principles for describing answers 1. Identifying the direction—finding patterns 2. Rearranging or making parts—numbering and noting 3. Writing down—inferring and deciding	D1, D2
C. Reveal problem: 7, 81, 302, 463, 56, 4, 25, 288, 70, 109 Find patterns from these numbers	* The principles of resolving problems 1. Find if there is pattern 2. Categorize these numbers according to participants' finding (for example, they may categorize these numbers as even and odd)	P1 P2 D1, D2

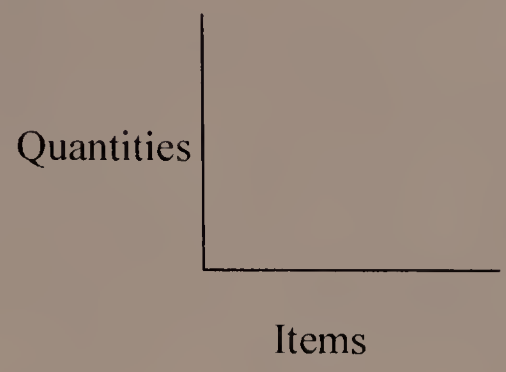
Continued, next page

Table 4.13, continued

	3. Describe results logically—reveal known conditions or axiom, display methods and procedures, and write down the inference and conclusion	
Activity II: Describing skills A. Do item 1-2 in worksheets "I" and discuss	1. Display the participants' works and have some discussions. 2. Reveal the focal points about how to **describe the procedures** (include the necessary tools, logical steps, and systematical framework).	D1
B. Do item 2-1-3 in worksheets "II" and discuss	1. Display the participants' works and have some discussions. 2. Reveal the focal points about how to **describe the results** (include displaying whole or part find, analyzing find, and writing down conclusions)	D2
Activity III: Construct figures A. Observe figure	The precise and complete figure has simple form (or style) and clear content	V2
B. Construct figure	Participants construct figures after they read the context of mathematical problems.	V1
C. Discuss and share the figures	Participants display their figures and share their opinions	
Activity IV: Find clues from figures A. Observe number line B. Observe bar chart and graph	1. Note the nature and style of number lines. 2. Get useful clues according to the illustrations	V2

Continued, next page

Table 4.13, continued

D. Observe table	The key for finding clues from bar chart and graph  Notice the titles, items, contents, and numbers.	
Activity: Observe behaviors in experiments A. Watch TV B. Discuss some topics	 Observe the behaviors (response, concentration, and fluency) in videotape. What do you find? How do you help your brother or sister avoid the behaviors?	E1, E2, E3

Evaluations and Results

Three evaluations were used to identify the effectiveness of the workshops. First, each classroom for every workshop was taped using four video cameras, so that the whole processes could be recorded. The records helped the researcher to observe the participants' habits of mind of the "experimenting" and interaction between partners. Second, the researcher could identify participants' habits in patterning, describing, and visualizing from checking the participants' paper work designed by the researcher for measuring and applying the habits. Third, every supervisor in every workshop focused on unique events and opinions for their field notes. There was a meeting for the researcher unique events and opinions for their field notes. There was a meeting for the researcher and the assistants to discuss and evaluate the students' performance after every workshop. The final meeting for workshop, the researcher and the assistants made decision for every participant's level in habits of mind in math. The results were displayed on table 4-14.

Table 4.14: Participants' Learning Results after Workshops

Levels of the habits of mind	Participants' number
Expert	11
Practitioner	19
Apprentice	1
Novice	0

Posttest

In the following section the procedures and results of the posttest will be presented. They include the displays of demographic characteristics of the participants, the descriptions of the collecting data procedures instrument, and the results of the statistical analysis.

The difference between posttest and pretest was that subjects and siblings worked together in the posttest, but not in the pretest. Therefore, there need to describe sibling characteristics (table 4-15). Sibling in this study, female were 30 (48%) and males were 32 (52%); 48% of sibling were fifth grade (n = 30) and 58 % of students were sixth grade (n = 32). Siblings in control group, females were 15 (48%) and males were 16 (52%); 58% of siblings were fifth grade (n = 18) and 42% of siblings were sixth grade (n = 13). In experimental group, females were 16 (52%) and males were 15 (48%); 39% of siblings were fifth grade (n = 12) and 61% of siblings were sixth grade (n = 19).

Table 4.15: Sibling's Gender and Grade

Items		Control group	Experimental group	Total
Gender				
Female	n	15	16	30
	%	***48***	***52***	***48***
Male	n	16	15	32
	%	***52***	***48***	***52***
Total		31	31	62
Grade				
5 grade	n	18	12	30
	%	***58***	***38***	***48***
6 grade	n	13	19	32
	%	***42***	***62***	***52***
Total		31	31	62

The posttest was used to examine participant's habits of mind in math. Most of steps were the same as the pretest—each group was divided into four subgroups, and every subgroup had seven or eight participants with two supervisors. Siblings were placed to work with subjects in the posttest in order to identify the effects of the workshop and the theory of the ZPD. This is the only difference between the pretest and the posttest.

The sources of data, the procedures for collecting, managing data and scoring were the same as the pretest. Even though there were some slight differences between the worksheet items of the pretest and the posttest, but the items of the posttest also were matched with the observing indicators of this study (see table 4-16). In the worksheets of the posttest, eleven behaviors in the "patterning", twenty in the "describing", and ten in "visualizing" were observed (table 4-17). Three aspects were observed in the "experimenting"—participants' responses (4 times), concentration (20 times—every 3 minutes being recorded during 1 hour), and fluency (4 times).

Table 4.16: Worksheet Items Matching Observational Indicators (Posttest)

Worksheets items	Observing indicators
Worksheets I: Making hundred chart	
I. We need to make a hundreds chart before you start the worksheets. Please write down your opinions or plan about how to make it. 1-1	D1: describing procedures
II. Please make a hundreds chard in the reverse side of this sheet then write the numbers 1 to 100 into the chart orderly.	V2: constructing figures D1: expressing procedures
Worksheet 2: Magic calculator	
Part I: 2-1	
A. Use a calculator and follow along the steps. 2-1-1 Press "ON/AC" key Press "0 + 1 +2" = = (keep pressing the "=" key) until you find 99	D1: following the described steps or procedures
B. Color green each number that show on the display in hundreds chart. 2-1-2	V1: constructing figures
C. What do you want to find out from the chart that you colored with green? 2-1-3	P1: having a habit to look for pattern D2: writing down the results V2: finding clues
D. Please observe your chart, especially the green parts. Write down every thing you find. 2-1-4	P2: finding and analyzing patterns D2: writing down the results D1: writing down the opinions step by step V2: finding clues
Part II: 2-2	
A. Use a calculator and follow along the steps. 2-2-1 Press "ON/AC" key Press "0 +10" = = = (keep pressing the "=" key) until you find 100	D1: following the described steps and procedure
B. Color yellow each number that show on the display in hundreds chart. 2-2-2	V1: constructing figures
C. What do you want to find from the chart that you colored with yellow? 2-2-3	P1: having a habit to look for pattern D2: writing down the results V2: finding clues

Continued, next page

Table 4.16, continued

<table>
<tr><td>D. Please observe your chart, especially the yellow parts. Write down every thing you find. 2-2-4</td><td>P2: finding a habit to look for pattern
D2: writing down the results
D1: writing down the opinions step by step
V2: finding clues</td></tr>
<tr><td colspan="2">Worksheets III: Finding information from tables</td></tr>
<tr><td>I. Observe the following table carefully and answer the questions. 3-1

What is the column? (   )

What is the column?
(   )
<table>
<tr><td></td><td></td></tr>
<tr><td>1. Mary</td><td>75, 80, 85, 90, ____</td></tr>
<tr><td>2. John</td><td>75, 85, 95, 105, ____</td></tr>
<tr><td>3.David</td><td>12, 14, 16, 18, _____</td></tr>
<tr><td>4.Tom</td><td>73, 75, 77, 79, _____</td></tr>
<tr><td>5.Jean</td><td>73, 173, 273, 373, ____</td></tr>
<tr><td>6.Luke</td><td>150, 152, 154, 156, ___</td></tr>
<tr><td>7.Lidia</td><td>115, 120, 125, 130, ___</td></tr>
<tr><td>8.Judy</td><td>56, 66, 76, 86, ____</td></tr>
</table>
</td><td>V1: constructing figures</td></tr>
<tr><td>II. Look at the table above and find the people whose numbers are "odd". 3-2
A. Answer: ______________________________. 3-2-1
B. Find and write down the same and different statements between your choices. 3-2-2</td><td>P2: finding and analyzing patterns

V2: finding clues from figures
D2: writing down the results
D1: writing down the opinions step by step</td></tr>
<tr><td>III. Look at Judy's number carefully from the table. 3-4
A. What do you want to find when you look at Judy's number? 3-4-1

B. What do you find from Judy's numbers (please write down your steps and results in details)? 3-4-2</td><td>P1: having a habit to look for pattern
D1: writing down the results
V2: finding clues
P2: finding and analyzing patterns
D2: writing down the results
D1: writing down the opinions step by step
V2: finding clues</td></tr>
</table>

Continued, next page

Table 4.16, continued

C. Whose characteristics of numbers are same as Judy? 3-4-3	P1: having a habit to look for pattern P2: finding and analyzing patterns D2: writing down the results D1: writing down the opinions step by step V2: finding clues
Worksheets IV: Making a Table	
Please categorize these numbers bellow and table or graph it. 16. 34. 58. 65. 93. 39, 71, 27, 62. 148。	
A. How do you categorize these numbers? Please write down your steps and results. 4-1	P1: having a habits to look for pattern P2: finding and analyzing patterns D1: writing down the opinions step by step D2: writing down the results
B. How do you make your table? Please write down your steps. 4-2	D1: writing down the opinions step by step
C. Display your table or graph in a space. 4-3	V1: constructing figures

Table 4.17: Times of Indicators Being Observed in the Posttest

Indicators / Times	Patterning		Experimenting			Describing		Visualizing	
	P1	P2	E1	E2	E3	D1	D2	V1	V2
Times of sub-indicators	5	6	4	20	4	11	9	5	5
Times of total	11		28			20		10	

The purpose of the statistical analysis is to explore further the significant difference between experimental group and control group in the posttest. The hypothesis in posttest was " Experimental group and control group have significant difference in the habits of mind in mathematics." To determine whether to accept or reject the hypothesis. this hypothesis should be restated in the null. The null hypothesis is " Experimental group and control group have no difference in the habits of mind in mathematics." This research used multivariate analysis of covariance to examine the results of the posttest. This analysis used the pretest as covariate to assess the dependant variables (posttest). The results of workshop influencing posttest were displayed on the table 4-18. There were significant differences on nine of the fourteen tests: total posttest (.001), post patterning (.001), post P01 (.001), and post P02 (.001), post describing (.001), post D01 (.001), post (.002), post visualizing (.010), post V01 (.007). There were no significant differences on the five tests: post experimenting (.162), post E01 (.087), post E02 (.133), post E03 (.494), and post V02 (.127).

Table 4.18: Results of Multivariate Analysis of Covariance

Dependent variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Total posttest	3.506	1	3.506	26.098	.001
Post patterning	13.612	1	13.612	50.123	.001
Post P01	29.345	1	29.345	59.358	.001
Post P02	3.845	1	3.845	15.315	.001
Post experimenting	.879	1	.879	2.015	.162
Post E01	1.341	1	1.341	3.036	.087
Post E02	4.081	1	4.081	2.336	.133
Post E03	.114	1	.114	.474	.494
Post describing	3.035	1	3.035	18.293	. 001
Post D01	3.641	1	3.641	14.531	.001
Post D02	2.485	1	2.485	10.251	.002
Post visualizing	1.234	1	1.234	7.245	.010
Post V01	1.878	1	1.878	7.775	.007
Post V02	.724	1	.724	2.409	.127

Table 4-19 displays the participants' means in the posttest. It is well to remember that the data are on a 4 point scale: 4 = expert, 3 = practitioner, 2 = apprentice, 1 = novice. Overall, the mean scores of the experimental group (M =2.6196) were higher than control group (M = 2.1250). The experimental group was on the level of low practitioner and the control group on the middle apprentice. In other word, the experimental group was better than the control group totally in the habits of mind in math.

In the category of patterning, the mean of the experimental group was 2.8226 and was on the level of middle practitioner, yet the mean of the control group was 1.8065 and was on middle apprentice. This indicates that the experimental group was significantly better than the control group in the patterning. In the P1, the mean of the experimental group was 3.19 and was on the level of middle practitioner, yet the mean of the control group was 1.74 and was on the level of low apprentice. That meant the experimental group was significantly better than control group in the P1. In the P2, the mean of the experimental group was 2.45 and was on the level of high apprentice, yet the mean of the control group was 1.87 and was on middle apprentice. This indicates that the experimental group was significantly better than control group in the P2.

In the category of describing, the mean of the experimental group was 2.2419 and was on the level of middle practitioner, yet the mean of the control group was 1.7581 and was on low apprentice. This indicates that the experimental group was significantly better than control group in describing. In the D1, the mean of the experimental group was 2.26 and was on the level of high apprentice, yet the mean of the control group was 1.74 and was on low apprentice. That means the experimental group was better than the control group in D1. In the D2, the mean of the experimental group was 2.23 and was on the level of high apprentice, yet the mean of the control group was 1.77 and was on the low apprentice level. These results show that the experimental group was significantly better than control group in the D2.

In the aspect of the visualizing, the mean of the experimental group was 2.8871 and was on the level of middle practitioner, yet the mean of the control group was 2.5806 and was on the low practitioner level. That means the experimental group was significantly better than control group in the visualizing. In the V1, the mean of the experimental group was 3.16 and was on the level of middle practitioner, yet the mean of the control group was 2.77 and was at low practitioner level. That mean the experimental group was better than control group in the V1. In the V2, the mean of the experimental group was 2.61 and was on the level of low practitioner, yet the mean of the control group was 2.39 and was on high apprentice.

Table 4.19: Comparing Means of the Posttest

Group		N	Mean	Std. Deviation	Sig.
Total pretest	Experimental group	31	2.6196	.4253	.001
	Control group	31	2.1250	.3811	
Patterning	Experimental group	31	2.8226	.6130	.001
	Control group	31	1.8065	.5272	
P1	Experimental group	31	3.19	.75	.001
	Control group	31	1.74	.73	
P2	Experimental group	31	2.45	.62	.001
	Control group	31	1.87	.50	
Experimenting	Experimental group	31	2.5269	.5694	.162
	Control group	31	2.3458	.7146	
E1	Experimental group	31	2.48	.57	.087
	Control group	31	2.26	.73	
E2	Experimental group	31	2.97	1.25	.133
	Control group	31	2.55	1.29	
E3	Experimental group	31	2.13	.34	.494
	Control group	31	2.26	.58	
Describing	Experimental group	31	2.2419	.5143	.001
	Control group	31	1.7581	.4056	
D1	Experimental group	31	2.26	.58	.001
	Control group	31	1.74	.51	
D2	Experimental group	31	2.23	.56	.002
	Control group	31	1.77	.50	
Visualizing	Experimental group	31	2.8871	.4951	.010
	Control group	31	2.5806	.5180	
V1	Experimental group	31	3.16	.52	.007
	Control group	31	2.77	.50	
V2	Experimental group	31	2.61	.72	.127
	Control group	31	2.39	.67	

CHAPTER 5

DISCUSSIONS AND IMPLICATIONS

The purpose of this study was to understand at-risk children's habits of mind in math and whether a workshop is an effective way to improve at-risk children's habit of mind in math. In order to study habits of mind, the researcher firstly reviewed the research literature. Next, an experiment was designed that included pretest, workshop, and posttest. There were sixty-two subjects and sixty-two siblings or peers participating the experiment. This study used the instrument and observation forms that were constructed by the researcher to collect data. SPSS was applied to the data, independent-sample t test, and multivariate analysis of covariance for using to analyze the data. Therefore, this section summarizes findings and explains the factors and conclusions. Finally some suggestions for at-risk children's math learning are made.

Findings

Generally speaking, the Vygotsky's ZPD theory was supported once again in this study when it was shown that siblings were capable of facilitating the learning of their younger brothers and sisters. The workshops were clearly successful in teaching participants' habits of mind in math because most of the items that were examined by statistical analysis revealed significant differences between the experimental and the control groups. Remember that these data are on a four point scare: 4 = expert, 3 = practitioner, 2 = apprentice, 1 = novice. The participants who worked in the experimental group reached the level (range) of practitioner, while the participants who were in the control group were on the level of apprentice. However, most of the participants were not expert in these habits.

In the aspect of patterning, there were significant differences between the experimental group and control group, and the mean of experimental group (M = 2.8226) was greater than the mean of control group (M = 1.8065). The participants who were in experimental group were on the level (range) of practitioner, but the participants who were in the control group were on the level of apprentice. In the P1 (having the habits to find patterns), there were significant differences between the experimental and control groups, and the mean of experimental group (M = 3.19) was greater than the mean of control group (M = 1.74). The participants in the experimental group were at the level (range) of practitioner, but the participants who were in the control group were on the level of apprentice. In the P2 (being able to find patterns), there were significant differences between the experimental and control groups, and the mean of experimental group (M = 2.45) was a little greater than the mean of control group (M = 1.87). The participants who were in experimental group were on the level (range) of high apprentice, but the participants who were in the control group were on the level of middle apprentice. Generally speaking, experimental group had high level in the habits of patterning, but control group gained very low scores in these habits.

In the aspects of experimenting, E1 (responding to problems immediately), E2 (concentrating on the processes), E3 (working fluently), there were no significant differences between experimental group and control group. Overall, all participants were low practitioners in the experimenting condition. In the E1, all participants were on the level of apprentice. In the E2, all participants were on the level of practitioner. In the E3, all participants were on the level of apprentice.

In describing, there were significant differences between experimental and control group, and the mean of the experimental group (M = 2.2419) was significantly greater than the mean of the control group (M = 1.7581). In the D1 (describing procedures), there were significant differences between experimental group and control group, and the mean of experimental group (M = 2.26) was greater than the mean of control group (M = 1.74). In the D2 (describing results), there were significant differences between experimental group and control group, and the mean of experimental group (M = 2.23) was a greater than the mean of control group (M = 1.77). Overall, most of participants were at the level of apprentice in the aspect of describing. From the results, the study found at-risk children were very weak in the describing.

In visualizing, there were significant differences between the experimental group and control group, and the mean of the experimental group (M = 2.8871) was greater than the mean of control group (M = 2.5806). In the V1 (constructing graphs), there were significant differences between experimental group and control group, and the mean of experimental group (M = 3.17) was greater than the mean of control group (M = 2.77). In the V2 (finding clues from graphs), there were no significant differences between experimental group and control group. Overall, all participants were on the level of the practitioner in these habits of mind.

Discussions

The results of the study are also consistent with previous research suggesting the importance of mixed-aged grouping and capable peer support which grant each child access to more knowledgeable and skillful companions (Berk, 1995; Evagelou, 1989; Kermani, 1997; Slavin, 1987). All subjects who joined the posttest were paired with their siblings or older peers, and most of these subjects received help from their partners. However, siblings and older peers needed to receive adequate training, so that they could give effective directions or help. For example, siblings or older peers should be knowledgeable and skillful with habits of mind and social interactions, so that they may lead their partners to develop habits of mind in math.

The workshop is an excellent way to train siblings or older peers as knowledgeable and skillful helpers. The contents of the workshop included the development and building up habits of mind in math (patterning, describing, visualizing, and experimenting) and the interacting skills necessary for success in the ZPD. There were four workshops for experimental group along with the following procedures: introduction, lecture presentation, activities or performances, and summary. Generally speaking, the workshops in this study were successful in teaching participants' habits of mind in math because the experimental group (siblings were in the workshops) had higher scores than control group (siblings were not in the workshops). In other words, the participants who were in the experimental groups had better habits of mind in math because their siblings or older peers had received some training in the workshops. The finding extends Horny's study (2000) about the functions of workshop.

In the category of patterning, the differences between the experimental group and the control group are great. It implies the experimental group received more stimulation in the area of patterning through the workshops. This finding extends the view of O'Thearling (1996) who suggested that the more at-risk children received stimulation, the more they grew in learning and development. These results can be used to explain why the experimental group had higher scores, specially, for the P1 (having a habits to find patterns). The P1 is easy to build up through reminding subjects continually. For example, the study emphasized continually that participants needed to remind themselves to find the patterns when they encountered math problem in the workshops or posttest. In addition, the P1 is a knowledge disposition that is easy to conceptualize. Based on both reasons, the P1 grew more quickly in a short-term training. Concerning the habit of P2 (can find patterns in math problems), the mean of experimental group is also higher than the control group. However, there is not a large difference between experimental group and control group. Much more time is needed to build up the habit because the P2 is a more skillful disposition (Cuoco, 1996). This study may not have given participants enough time to familiarize themselves with this habit.

There were no significant differences between the experimental group and control group in the aspects of experimenting. We also found all participants are on the level of the low practitioner. In other words, the workshop did not significantly influence participants' habit in the experimenting, but siblings paired with subjects in the posttest produced only temporary effects. To investigate the failure of the workshop, one possibility might be that participants who were in the experimental group did not have enough time to familiarize themselves with these habits of mind. According to the previous studies at-risk children had the characteristics of low motivation, lack of consistency, and low self-regulation (Bauer, 2001; Donnelly, 1987; Howerton, 1994; O'Thearling, 1996). These characteristics are related to E1 (responding immediately—low motivation), E2 (concentration—lack of consistency) and E3 (fluency—low self-regulation). These negative characteristics need much time to transform into positive behaviors. However, this study did not give participants enough time to complete the transforming processes. Next about siblings working with subjects, the study found the companioning processes produced some positive habits temporarily in the posttest, especially in the E2. According to the Lamorey's study (1999), at-risk children have higher rates of disciplinary problems that are connected to impulsive un-concentrated behaviors. However, the experimental group and control group were all on the level of practitioner in the E2. It implies subjects concentrated more in the processes of resolving problems when the siblings or older peers work with them. This finding confirms and extent the arguments "family members should spend time working with children and check their learning outcomes (Ascher, 1988; Barker, 1998; Rich, 1988)."

There were significant differences between the experimental group and the control group in the describing, D1 (describing the procedures), and D2 (describing the results). These results imply that the workshop significantly influenced participants' habit in this area. However, most of participants are on the statement of the apprentice level. That means the participants were very weak in the habits of describing. One of reasons might be related to the participants' literacy and logical abilities. At-risk children are not easy to describe the procedures and results with the proper word-describing logically and systemically if they had not received these knowledge and skills (Kasten, 1988). This study confirms the results of the previous studies: at-risk children receive insufficient training from literacy and logicality (Galambos, 1995; Onslow, 1992; Schwartz, 1987). Even though it is difficult to improve these habits of mind in the short-term workshop, but the means of the experimental group were higher than control group. Therefore, this study confirm the worth and function of workshop. In other words, sibling workshops are another way to help at-risk children learn the habits of describing.

In the area of the visualizing, most of the participants were at the level of the practitioner. This implies participants are able to understand math through the visual graphs or diagrams. According to Connor's view (1990), at-risk children have difficulty with the abstract nature of math. Therefore, it is important to display the materials with graphs or diagrams for at-risk children, especially native people who have a learning style that emphasizes images. Native Taiwanese always use many images to express cultural symbolism (Chen, 1992), so that the learning material with graphs or diagrams were understood easily by Native Taiwanese children. Another issue is that at-risk children tend to use graphs and diagrams related to children's literacy. According to the results of research from ERIC Clearinghouse for Languages and Linguistics (1997), literacy is the most important factor for academic achievement. Green's study (1995) also found that at-risk children had low academic achievement. This implies at-risk children's literacy might not be sufficient for understanding math. This forces at-risk children to use other ways to understand and resolve math problems. Graphs or diagrams may supply an easier way for them. The mean of the experimenting group was higher than the control group. That means the workshop gave an advantage to at-risk children's habits in the aspect of visualizing, especially in V1 (constructing graphs or diagrams) because constructing graphs or diagrams are necessary to understand how and to memorize the constructing processes. There was no significant difference between the experimental group and control group in the V2 (finding clues from graphs and diagrams). However, if we compare the means of both groups, the experimental group ($M = 2.61$) was higher than control group ($M = 2.39$). That means the time of workshops was an important factor because V2 is related to critical thinking that requires more learning. If the time were long enough for workshop and interaction activities, the score of the experimental group would be higher.

In sum, our data has shown that patterning is easy to build up because it is a more knowledge based and disposition that is easy to conceptualize. Visualizing comes next because it is close to at-risk children's learning style that uses more images to understand abstract materials. Describing is more difficult because it is related to at-risk children's literacy and logical training that need more strategies and lessons to learn. Experimenting is most difficult because it belong to the emotional area that is influenced easily and does not produce stable results. All of these habits of mind can be built up through applying Vygotsky's ZPD theory and conducting sibling workshops, but much time is needed to practice.

Conclusions

At-risk Students Must and Can Learn the Habits of Mind in Math

At-risk children must learn the habits of mind in math. Even though at-risk children have many challenges in math learning, they still need to learn math because math is the foundation of every scientific subject that supplies greater opportunities to gain opportunities for employment. Students who are building habits of mind are more disposed to draw upon previously learned habits when they are faced with uncertainty or challenging problems. In this study, four habits of mind of math (patterning, experimenting, describing, and visualizing) were chosen because they were more easily observed. The results of statistical analysis indicate that at-risk children can learn the habits of mind of math. A four-point scale was used to categorize knowledge of habits of mind: 1 novice, 2 apprentice, 3 practitioner, 4 expert. Most of participants were on the novice level when they took the pretest. However, participants showed significant growth in the areas of patterning, experimenting, describing, and visualizing after the workshops. Participants in the experimental group learned aspects of patterning and visualizing more easily because it is easier to conceptualize the knowledge. Describing and experimenting came next because they were more complex and more time was necessary to build habits of mind.

Siblings or Peers Might Be an Important Supporting Resource

Siblings or capable peers are important resources for at-risk children's learning habits of mind of math. At-risk children's parents generally have low family involvement because of their low socioeconomic status, low educational backgrounds, and minimal educational expectations. Therefore, it is very hard to work with them. For example, some at-risk children's parents work overtime, have second and part time jobs because of their low socioeconomic status, so they are not able to check children's homework. According to Vygotsky's ZPD theory and his follower's, siblings or older peers are important resources if they receive adequate trainings. The results of the study also confirmed that siblings or older peers are an important supporting system for at-risk children. For example, at-risk children do not respond immediately because they have low motivation for many matters. This study found that the time that subjects took to respond to the problems was shorter when siblings or peers worked with subjects. Of course, the issue about siblings or older peers still has many challenges like how to train them, how long will it be, what are the practical ways to complete the training, etc. Fortunately, the workshop gives us ways of defining habits of mind and procedures for practicing and researching the teaching these habits.

Workshop Are an Effective Way for Helping At-risk Children Learn

Workshops supply an effective way for at-risk children to learn the habits mind of math. There are many kinds of workshops for different purposes. In this study, the researcher set up the workshops with a formal learning routine, and each workshop was divided into four parts: introduction, lecture presentation, small-group discussion, and summary. In this study, the purpose of the workshops was to teach habits of mind of math to make at-risk children more skillful and knowledgeable when facing problems that are related to the math. In addition, at-risk children's ZPD will be strengthened and developed with the involvement of siblings or older peers. According to the results of the study, we can conclude that the workshops play a successful role for blending both—learning habits of mind and sibling involvement.

Implications

Even though our understanding of at-risk's math learning has grown in the past, additional practice and research is needed to better understand their learning characteristics and needs. Drawing from the research studies reviewed and my own research study, new practice and future research should consider the following elements.

Teaching At-risk Children Habit of Mind in Math Classes

Math teachers need to teach habits of mind in classes, especially for at-risk children. Even though there were not many studies of the relation between math achievement and habits of mind in math, it cannot be denied that learning habits of mind in math may help at-risk children face and solve math problems more comfortably and confidently. At-risk children will learn math with less anxiety if teacher teach habits of mind of math like patterning, experimenting, describing, and visualizing. Many teachers are concerned that teaching habit of mind will add to their burden in math classes. Actually, teaching habit of mind does not bring extra works in class. In contrary, it may simplify and systematize the work in math learning. Teachers just need to check the materials that are related to patterning, experimenting, describing, and visualizing. Notice that "habits of mind" is a group of teachable "habits" that allow children to learn more effectively.

Siblings or Peers Becoming Learning Support System in an At-risk Area

Siblings or capable peers may be organized and trained as a learning support system for at-risk children under teachers' supervision. Many studies have already confirmed that mixed-age learning groups are powerful, especially for at-risk children. However, these studies also suggested the tutors need to be organized as groups and received adequate training, so that they may serve effectively. Either in class or in the school system, the groups may be organized under the teacher's guidance. Family involvement is often weak in at-risk children's homes. Siblings or capable peers are more useful resources for at-risk children's learning because they are more flexible and knowledgeable than other members in their family. For the class level, teachers can use peer tutors in classes to help at-risk children learn; but at the school level, siblings or older peers can be grouped to help at-risk children at a particular time like after school or self-study class.

Further Study

The results of the study require further research. One of the important factors was the problem of time, especially in the workshops. To teach habits of mind in math a long period of time is needed. Even though there was some progress after one-month workshops, it is difficult to predict big changes in these habits. If there was a longer time for workshops and siblings-subjects interaction, it is quite likely that the children will show greater progress.

Extending the research samples and sampling area will provide more useful data. There were 62 subjects and 62 siblings participating from two schools. If there is a larger sample, it is recommended that we double the number of subjects and siblings in the experiments while choosing from at least four schools and various districts. It will be interesting to compare the results and find out if there are significant differences between experimental and control groups with this larger sample.

Moreover, we recommend that more researchers study the positive relationship between math achievement and habits of mind of math. Even though this study found the habits of mind of math were a group of dispositions that might help participants facing and resolving problems. It will be useful for math education to develop teaching strategies that reinforce and support the relationship between math achievement and the habits of mind.

Finally, this study is concerned with developing more effective methods to evaluate habits of mind in math learning. The methods and tools of evaluating habits of mind in this study are very complex because of the need for real teaching in math class. It will be very helpful to simplify and systemize the observing procedures and evaluating results will be useful for teaching habits of mind in math class.

APPENDIX A

WORKSHEETS FOR PRETEST

Worksheet 1: Making a Hundred Chart

I. We need to make a hundreds chart before you start the worksheets. Please write down your opinions or plan about how to make it. 1-1

II. Please make a hundreds chart in the reverse side of this sheet then write the numbers 1 to 100 into the chart orderly. 1-2

Worksheet 2: Magic calculator

There are two activities in the following section. You need a calculator to do them. Please finish it according to the direction and record the results

Part I: 2-1

A. Use a calculator and follow along the steps. 2-1-1

Press “ON/AC” key

Press “0 +2” = = = (keep pressing the “=” key) until you find 100

B. Color green each number that show on the display in hundreds chart. 2-1-2

C. What do you want to find out from the chart that you colored with green? 2-1-3

D. Please observe your chart, especially the green parts. Write down every thing you find. 2-1-4

Part II: 2-2

A. Use a calculator and follow along the steps. 2-2-1

Press “ON/AC” key

Press “0 +5” = = = (keep pressing the “=” key) until you find 100

B. Color yellow each number that show on the display in hundreds chart. 2-2-2

C. What do you want to find from the chart that you colored with yellow? 2-2-3

D. Please observe your chart, especially the yellow parts. Write down every thing you find. 2-2-4

Worksheets III: Finding information from tables

I. Observe the following table carefully and answer the questions. 3-1

What is the column? (   )

What is the column?
(   )

1. Mary	75, 80, 85, 90, ____
2. John	75, 85, 95, 105, ____
3.David	12, 14, 16, 18, _____
4.Tom	73, 75, 77, 79, _____
5.Jean	73, 173, 273, 373, ____
6.Luke	150, 152, 154, 156, ___
7.Lidia	115, 120, 125, 130, ___
8.Judy	56, 66, 76, 86, ____

II. Look at the table above and find the people who number are "even number". 3-2

A. Answer: ____. 3-2-1

B. Find and write down the same and different statements between your choices. 3-2-2

III. Look at the table above and find the people who number are "skip-count by 5s". 3-3

A. Answer: ____. 3-3-1

B. Find and write down the same and different statements between your choices. 3-3-2

Worksheets IV: Making a Table

Please make a table according to the statement that people and number were matched.

1. Mary	A. 75,80,85,90,
2. John	B. 75,85,95,105,
3.David	C.12,14,16,18,
4.Tom	D.73,75,77,79,
5.Jean	E.73,173,273,373,
6.Luke	F.150,152,154,156,
7.Lidia	G.115,120,125,130,
8.Judy	H.56,66,76,86,

I. Observe the tables below. Which table you will choose? 4-1

1. ☐ Table A; ☐ Table B. 4-1-1

2. Why? 4-1-2

II. According to your choice, put the names and numbers in the tables. 4-2

Table A

Table B

III. Look at Judy's numbers and answer the questions. 4-3

A. Fill out a serial numbers: 150, 152, 154, 156, __, __, __, __. 4-3-1

B. Why do you write down these numbers? 4-3-2

IV. Look at Luke's numbers and answer the questions. 4-4

A. Fill out a serial numbers: 115, 120, 125, 130, __, __, __, __. 4-4-1

B. Why do you write down these numbers? 4-4-4

APPENDIX B

WORKSHEETS FOR POSTTEST

Worksheet 1: Making a hundred chart

I. We need to make a hundreds chart before you start the worksheets. Please write down your opinions or plan about how to make it. 1-1

II. Please make a hundreds chart in the reverse side of this sheet then write the numbers 1 to 100 into the chart orderly. 1-2

Worksheet 2: Magic calculator

There are two activities in the following section. You need a calculator to do them. Please finish it according to the direction and record the results

Part I: 2-1

A. Use a calculator and follow along the steps. 2-1-1

Press "ON/AC" key

Press "0 +1+ 2" = = = (keep pressing the "=" key) until you find 99

B. Color green each number that show on the display in hundreds chart. 2-1-2

C. What do you want to find out from the chart that you colored with green? 2-1-3

D. Please observe your chart, especially the green parts. Write down every thing you find. 2-1-4

Part II: 2-2

A. Use a calculator and follow along the steps. 2-2-1

Press "ON/AC" key

Press "0 +10" = = = (keep pressing the "=" key) until you find 100

B. Color yellow each number that show on the display in hundreds chart. 2-2-2

C. What do you want to find from the chart that you colored with yellow? 2-2-3

D. Please observe your chart, especially the yellow parts. Write down every thing you find. 2-2-4

Worksheets 3: Finding information from tables

I. Observe the following table carefully and answer the questions. 3-1

What is the column? (   )

What is the column?
(   )

1. Mary	75, 80, 85, 90, ____
2. John	75, 85, 95, 105, ____
3.David	12, 14, 16, 18, _____
4.Tom	73, 75, 77, 79, _____
5.Jean	73, 173, 273, 373, ____
6.Luke	150, 152, 154, 156, ___
7.Lidia	115, 120, 125, 130, ___
8.Judy	56, 66, 76, 86, ____

II. Look at the table above and find the people who number are "odd number". 3-2

A. Answer: ____. 3-2-1

B. Find and write down the same and different statements between your choices. 3-2-2

III. Look at Judy's number carefully from the table. 3-4

A. **What do you want** to find when you look at Judy's numbers. 3-4-1

B. What do you find from Judy's numbers (please write down your steps and results in details)? 3-4-2

C. Whose characteristics of numbers are same as Judy? 3-4-3

Worksheets IV: Making a Table

Please categorize these numbers bellow and table or graph it.

16, 34, 58, 65, 93, 39, 71, 27, 62, 148

A. How do you categorize these numbers? Please write down your steps and results. 4-1

B. How do you make your table? Please write down your steps. 4-2

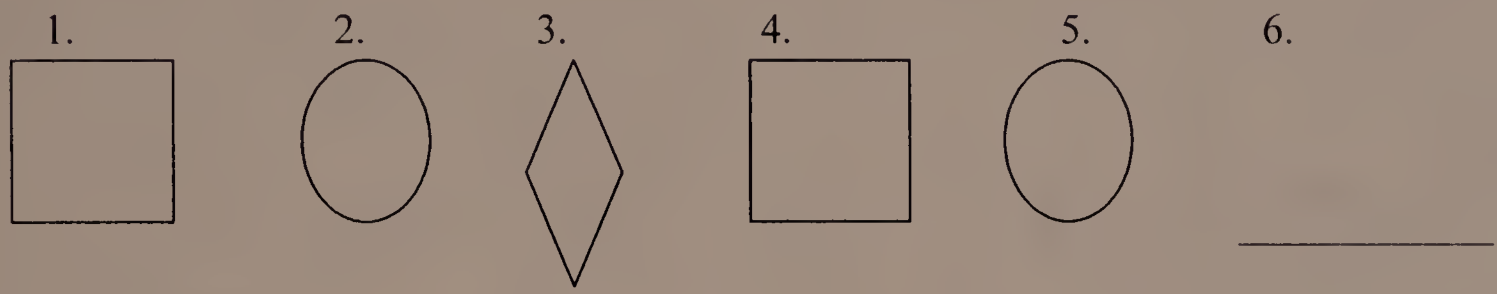
C. Display your table or graph in a space. 4-3

APPENDIX C

WORKSHEETS FOR WORKSHOPS

A. Discussion: What would you think when you face a math problem?

B. Resolve the following question and write down your procedures, reasons, and results.



C. Find patterns from the following numbers: 7, 81, 302, 463, 56, 4, 25. 288. 70. 109.

D. Please make a table or graph according to the results of the "C"

E. How do we find clues from contexts and graphs?

F. Observing phenomena from videotapes and discuss the following questions?

1. What do you find?

2. How can we help our sisters or brothers responding problems quickly, concentrating in processes, and working more fluent?

APPENDIX D

RECORDING FORMS FOR OBSERVING VIDEOTAPES

Time of responding to item	**Under 5 seconds**	**5 to 10 seconds**	**11 to 15 seconds**	**Over 16 seconds**
Concentration	**Glancing right and left**	**Improper posture**	**Leafing over paper**	**Other actions**
Fluency in processes	**Very fluent**	**Fluent**	**Still fluent**	**Not fluent**

APPENDIX E

MEASURING FORMS FOR HABITS OF MIND OF MATH

Indicators	Scoring	Revised contents	Scores
Patterning	Expert (4)	1.Subject searches 3 times for pattern when solving a math problem. 2.Subjects can find patterns in the context of math and analyze the characteristics of pattern completely and accurately	
	Practitioner (3)	1. Subject searches 2 times for pattern when solving a math problem 2.Subjects can find patterns in the context of math and analyze the characteristics of pattern completely.	
	Apprentice (2)	1 Subject searches 1 times for pattern when solving a math problem 2.Subjects can find patterns in the context of math, but can't analyze the characteristics of pattern.	
	Novice (1)	1. Subject does not search for pattern when solving a math problem 2.Subjects can't find patterns in the context of math and analyze the characteristics of pattern.	
Experimenting	Expert (4)	1.Subject responds problems under 5 seconds. 2.Subject is very concentrative in the process of resolving problems (under 5 times). 3.The processes are very fluent in subject's works.	
	Practitioner (3)	1.Subject responds problems from 5 to 10 seconds. 2.Subject is concentrative in the process of resolving problems (under 5 times). 3.The processes are fluent in subject's works.	
	Apprentice (2)	1.Subject responds problems from 11 to 15 seconds. 2.Subject is less concentrative in the process of resolving problems (11to 15 times). 3.The processes are less fluent in subject's works.	
	Novice (1)	1.Subject responds problems over 16 seconds. 2.Subject is not concentrative in the process of resolving problems (over 16 times). 3.The processes are not fluent in subject's works.	

Describing	Expert (4)	1.Subject gives precise and complete descriptions of the steps in a process. 2.Subject writes down his /her thought, results, conjectures, arguments, proofs, questions, and opinions precisely and completely.	
	Practitioner (3)	1.Subject gives complete descriptions of the steps in a process. 2.Subject writes down his /her thought, results, conjectures, arguments, proofs, questions, and opinions completely.	
	Apprentice (2)	1.Subject gives incomplete descriptions of the steps in a process. 2.Subject writes down his /her thought, results, conjectures, arguments, proofs, questions, and opinions incompletely.	
	Novice (1)	1.Subject can`t give descriptions of the steps in a process. 2.Subject can`t write down his /her thought, results, conjectures, arguments, proofs, questions, and opinions.	
Visualizing	Expert (4)	1.Subject constructs precise and complete tables or graphs from descriptions of mathematical problems. 2.Subject finds precise and complete clues that can resolve mathematical problems from the tables or graphs.	
	Practitioner (3)	1.Subject constructs complete tables or graphs from descriptions of mathematical problems. 2.Subject finds complete clues that can resolve mathematical problems from the tables or graphs, but not precise.	
	Apprentice (2)	1.Subject constructs imprecise and incomplete tables or graphs from descriptions of mathematical problems. 2.Subject finds precise and complete clues that can resolve mathematical problems from the tables or graphs, but not precise and complete.	

	Novice (1)	1.Subject can't construct tables or graphs from descriptions of mathematical problems. 2.Subject can't find clues that can resolve mathematical problems from the tables or graphs.	

BIBLIOGAPHY

Abdal-Haqq, Ismat. (1993). Integrated services: New roles for schools, new challenges for teacher education. Washington, DC: ERIC Clearinghouse on Teacher Education.

Arisa, Simone., & Hitchens, Marilynn. (1998). Teaching world history: The global human experience through time. Indiana: ERIC Clearinghouse for Social Studies/Social Science Education.

Arthur Costa., & Bena Kallick. (2000). Assessing and reporting on habits of mind. New York: Association for Supervision and Curriculum Development.

Ascher, Carol. (1988). Improving the school-home connection for low-income urban Parents. New York: ERIC Clearinghouse on Urban Education.

Bailin, Sharon., & Case, Roland. (1999). Conceptualizing critical thinking. Journal of Curriculum Studies, v31, n3, p285-302.

Ballantine, J. H. (1999). Getting involved in our children's education. Childhood Education, v75, n3, p170-71.

Barker, Amy J l., & Soden, Laura M. (1998). The challenges of parent involvement research. New York: ERIC Clearinghouse on Urban Education.

Bashmueller, Charles F. (1992). The core ideas of "CIVITAS: A framework for civic education. Illinois: ERIC Clearinghouse for Social Studies/Social Science Education.

Bauer, Denise S., & Lupo, Jennifer L. (2001). Improving attitudes in reading through multiple instructional strategies in an at-risk environment. Illinois: Master of Arts Action Research Project, Saint Xavier University and SkyLight Professional Development.

Becker-Klein, Rachel. (1999). Family and school level barriers to family involvement. New York: The Biennial Meeting of the Society for Research in Child Development.

Berk Laura E., & Winsler Adam. (1995). Scaffolding children's learning: Vygotsky and early childhood education. Washington, DC: National Association for the Education of Young Children.

Boyes, Michael., & others. (1993). Internalization of social discourse: A Vygotskian account of the development of young children's theories of mind. New Orleans: The Biennial Meeting of the Society for Research in Child Development.

Brickle, Woodrow, II. (1990). Improving the problem solving skills of at-risk high school mathematics students through cooperative work group and computer-assisted instruction. Georgia: Ed.D. Practicum Report, Nova University.

Bryan, Jan K. (1996). Literacy partnerships and scaffolding: Revisiting Vygotsky, Bassets, and Border Collies. New York: The Annual Conference of the American Educational Research Association.

Bryant, Veronica A. (1992). Improving mathematics achievement of at-risk and targeted students in grades 4-6 through the use of manipulatives. Maryland: Ed.D. Practicum, Nova University.

Caldwell, Jean. (1989). Families tackle math as a game--together. Equity & Choice, v5, n1, p21-23.

Calhoun, E. F., & C.G. Glickman. (1993). Issues and dilemmas of action research in League of Professional Schools. Paper presented at the annual meeting of the American Educational Research Association, Atlanta.

Callison, Daniel. (2001). Scaffolding. School Library Media Activities Monthly, v17, n6, p37-39.

Charnitski, Christina Wotell., Harvey, Francis A. (1999). Integrating science and mathematics curricula using computer mediated communications: A Vygotskian Perspective. Pennsylvania: The National Convention of the Association for Educational Communications and Technology.

Chen, Chi-Lu. (1992). Native Taiwanese's culture. Taipei: Lien Ching.

Chen, Tien-Chu. (1990). Promote elementary education and carry out educational equivalence. Taiwan Education, n474, p1-24.

Chen, Yin-Hao., Wang, Jung-Mu., & Lee, Kun-Chyng. (1993).The research of middle and elementary school students' learning adjustment and relative factors in Taiwan. Friends of Elementary Education, v44, n3, p5-14.

Chien, Nao-Fa. (1990). Improving projects of reducing the differences between urban and rural education. Counsel of Elementary Education, v29, n5, p53-63.

Connor, Timothy J. (1990). Learning to program in BASIC through the use of graphics. New York: New York Institute of Technology.

Cook, Gillian E. (1996). Using clinical supervision to promote inquiry. Journal of Staff Development, v17, n4, p46-50.

Coxford, Arthur F., & Fey, James T. (1998). Contemporary cathematics in context: A unified approach. Core-Plus Mathematics Project: scope & sequence. Chicago: Everyday Learning Corp.

Craig Grace. J. 1996. Human development. New Jersey: Prentice-Hall.

Cuoco, Al., Coldenberg E, Paul., & Mark, June. (1996). Habits of mind: an organizing principle for mathematics curricula. Journal of Mathematical Behavior, v15, 375-402.

Desimone Laura. (1999). Linking parent involvement with student achievement: Do race and income matter? The Journal of Education Research, v93, n1, p11-30.

Dods, Richard F. (1996). Insights into problem-based learning as applied to understanding a scientific discipline. Ncsssmst Journal, v2, n1, p11-18.

Dominic Peressini. (1996). Parents, power, and the reform of mathematics education: An exploratory analysis of three urban high schools. Urban Education, v31, n1, p3-28.

Donnelly, Margarita. (1987). At-risk students. Oregon: University of Oregon

Doolittle, Peter E. (1997). Vygotsky's Zone of Proximal Development as a theoretical foundation for cooperative learning. Journal on Excellence in College Teaching, v8, n1, p83-103.

Drake, Frederick D. (1997). Using alternative assessments to improve the teaching and learning of history. Illinois: ERIC Clearinghouse for Social Studies/Social Science Education.

Edwards, Thomas., Kahn, Steven., & Brenton, Lawrence. (2001). Math corps summer camp: An Inner city intervention program. Journal of Education for Students Placed at-Risk, v6, n4, p411-26.

Elliott, Alison., & Hall, Neil. (1997).The impact of self-regulatory teaching strategies on" at-risk" preschoolers' mathematical learning in a computer-mediated environment. Journal of Computing in Childhood Education, v8, n2, p187-98.

Epstein, J. (1990). School and family connections: Theory, research and implications for integrating sociologies of education and family. In D. Unger and M. Sussman (eds) Families in community settings: Interdisciplinary Perspectives. New York: Haworth Press, p99-126.

ERIC clearinghouse on languages and linguistics. (1997). From at-risk to excellence: principles for practice. Washington, DC: Office of Educational Research and Improvement.

Espinosa, Linda M. (1995). Hispanic parent involvement in early childhood programs. Illinois: ERIC Clearinghouse on Elementary and Early Childhood Education.

Evangelou, Demetra. (1989). Mixed-age groups in early childhood education. Illinois: ERIC Clearinghouse on Elementary and Early Childhood Education

Galambos, Nancy L., Sears, Heather A., Almeida, David M., & Kolaric, Giselle C. (1995). Parents' work overload and problem behavior in young adolescents. Journal of Research on Adolescence, v5, n2, p201-223.

Garbarino, James., & Abramowitz. H. Robert. (1993). Children and families in the social environment: socialocultural risk and opportunity. New York: Aldin De Gruyter.

Green, Patricia., Scott, Leslie. (1995). "At-risk" eighth-graders four years later statistics in brief. New York: National Opinion Research Center.

Hanson, S. L., & Ginsburg, A. (1985). Gaining ground: Values and high school success. Washington, DC: U.S. Department of Education.

Harvey, Francis A., Charnitsky, Christina Wotell. (1998). Improving mathematics instruction using technology: A Vygotskian perspective. Pennsylvania: The National Convention of the Association for Educational Communications and Technology (AECT).

Hornby, Garry. (2000). Improving parental involvement. New York: Cassell.

Howerton, D lynn., Enger, John M., & Cobbs, Charles R. (1994). Self-esteem and achievement of at-risk adolescent black males. Research in the Schools, v1, n2, p23-27.

Intercultural Development Research Association. (1996).Math and science education. IDRA focus. Idra Newsletter, v23, n6.

Jones, Claudia. (1988). Parents are teachers, too. Vermont: Williamson Publishing Co.

Jones, G. A., C. A. Thornton (1993). Vygotsky revisited: Nurturing young children's understanding of number. Focus on Learning Problems in Mathematics, v15, n2, p18-28.

Karther, D. E., & Lowden, F. Y. (1997). Fostering effective parent involvement. Contemporary Education, v69, n1, p41-44.

Kasten, Margaret., & Howe, Robert W. (1988). Students at risk in mathematics: implications for elementary schools. ERIC/SMEAC Mathematics Education Digest No. 2. Washington, DC: Office of Educational Research and Improvement.

Katz, lilian G. (1999). Distinctions between academic and intellectual goals in early childhood education. Illinois: The Annual European Early Childhood Research Conference (9th).

Kermani, Hengameh., & Mahanaz, Mahnaz. (1997). Cross-age tutoring: Exploring features and processes of peer-mediated learning. North Carolina: The Annual Meeting of the American Educational Research Association.

Knowles, M. S. (1978). The adult learner: a neglected species. Houston: Gould Publishing.

Kokoski, Teresa M., & Downing-Leffler, Nancy. (1995). Boosting your science and math programs in early childhood education: making the home-school connection. Young Children, v50, n5, p35-39.

Kovac-Cerovic, Tunde. (1996). How can we as parents and educators foster metacognitive development? Yugoslavia: Childhood Education--International Perspectives

Kuan, Fu-Yung. (1987). Correlation research of middle school students` self-concept, motivation, and academic achievement in Taiyan area. National Chengchi University.

Lai, Yu-Fen. (1995). Comparing research between Native Taiwanese and non-Native Taiwanese in children's learning adaption and self-concept. National Hualien Teachers College Master Thesis.

Lamorey, Suzanne., & Leigh, Jim. (1999). Contemporary issues education: Rural risks, obstacles and resources. Arizona: Conference Proceedings of the American Council on Rural Special Education (19^{th}).

Lee, Chien-Hsing. (1996). The current statement and development of Aboriginal education in Taiwan. Quarterly Publication of Aboriginal, n2, p3-8.

Lee, Kun-Chung. (1990).The research of elementary school students' learning adjustment and relative factors in Taiwan. National Tainun Teachers College Journal, n23, p133-139.

Lewis, Warren. (1997). Whole language and adult education. Indiana: ERIC Clearinghouse on Reading, English, and Communication.

Lu, Chiang. (1987).The research of middle school students' self-concept, living adjustment, and academic achievement. National Taiwan Normal University Master Thesis.

Mcgee, Kathleen A., & Powell, Joyce M. (1996). Improving learner responsibility by utilizing thinking strategies and cooperative learning. Illinois: Master's Action Research Project, Saint Xavier University.

McLachlan-Smith, Claire. (1991). Emergent literacy in New Zealand: An examination of promotion and practices in early childhood centers. New Zealand: The Early Childhood Convention (5th, Dunedin).

McMillan, James H., & Schumacher, Sally. (2001). Research in education: A conceptual introduction. New York: Longman.

Mei, Yuan-Yuan. (1995).Correlation research about teachers' satisfaction and morale in Hualien and Taitung counties. National Hualien Teachers College Master Thesis.

Ministry of Interior (2001). Populations of Native Taiwanese. Taipei: MOI Statistical Information Service.

Moreno, Robert P. (2000). Teaching everyday and school related tasks: Effective instruction among Mexican-American mothers--JSRI Working Paper No. 48. Michigan: Michigan State University, East Lansing. Julian Samora Research Inst.

Morgan, A. (1993). Training responses to the changing role of parents. Community Education Network, v13, n6, p2-3.

Nassaji, Hossein., & Swain, Merrill. (2000). Vygotskian perspective on corrective feedback in L2: The effect of random versus negotiated help on the learning of English articles. Language Awareness, v9, n1, p34-51.

Neil, Marilyn. (1994). Parent-teacher partnerships: Enhancing learning in mathematics. Georgia: The Association for childhood Education International Study Conference.

New, Rebecca S. (1993). Reggio Emilia: Some lessons for U.S. educators. Urbana: ERIC Clearinghouse on Elementary and Early Childhood Education.

Onslow, Barry. (1992). Improving the attitude of students and parents through family involvement in mathematics. Mathematics Education Research Journal, v4, n3, p24-31.

Organization of History Teachers. (1993). History as the core of the precollege social studies curriculum--A Statement of Policy. Chicago: Organization of History Teachers.

O'Thearling, Sibyl., & Bickley-Green, Gynthia Ann. (1996). Art education and at-risk youth: Enabling factors of visual expressions. Visual Arts Research, v22, n1, p20-25.

Pallas, Aaron M. (1989). Making school more responsive to at-risk students. New York: ERIC Clearinghouse on Urban Education.

Pellegrini, Anthony D., & Others. (1986). The effect of children's communicative status and task on parents' teaching strategies. Contemporary Educational Psychology, v11, n3, p240-52.

Pfleger, Margo. (1985). The PASS program: Preparation for american secondary schools. Washington, DC: Refugee Service Center--Center for Applied Linguistics

Pollard, Vincent Kelly. (1999).Hawaii youth at risk? Conceptual challenges in communicating a statewide mentoring initiative. Hawaii: Hawaii University.

Portes, Pedro R & others. (1994). Assistance in Science-Related Parent-Child Interactions: Problem Solving in the Zone of Proximal Development (ZPD). New Orleans: The Annual Meeting of the American Educational Research Association.

Reynolds, Mary Ruth., & Others. (1996). Focusing on child-constructed stories: Videotaping classroom play centers. Tuscaloosa: The Annual Meeting of the Mid-South Educational Research Association.

Rich, Dorrothy. (1987). Teachers and parents: An adult-to-adult approach. Washington D.C: National Education Association.

Richardson, Michelle., & Simmons, Deborah. (1996). Recommended competencies for outdoor educators. West Virginia: ERIC Clearinghouse on Rural Education and Small Schools.

Rodriguez, Jorge. (1997). "At-risk": A measure of school failure in American education. New York: The Annual Meeting of the American Educational Research Association.

Rogers, C. R. (1980). A way of Being. Boston: Houghton Mifflin.

Rosebery, Ann S., Warren, Beth. (2000). Children's way with words in science and mathematics: a conversation across disciplines. Massachusetts: National Center for Improving Student Learning and Achievement in Mathematics and Science

Russell, Robert. (1996). Science and mathematics education reform: What do parents need to know to get involved? Washington, DC: American Association for the Advancement of Science.

Schwartz, Wendy. (1987).Teaching science and mathematics at risk student. New York: ERIC Clearinghouse on Urban Education, Institute on Urban and Minority Education.

Sears, Nedra C., & Medearis, Linda. (1992). Natural math: A progress report on implementation of a family involvement project for early childhood mathematics among children of the Oklahoma Seminole Head Start and Boley Head Start. Oklahoma: The Meeting of the Rocky Mountain Research Association.

Sher, Beverly.(1992). Developing a scope and sequence in science for high ability learners K-8—Developing science curriculum for high ability learners K-8. Virginia: College of William and Mary, Williamsburg.

Slavin, R.E. (1987). Developmental and motivational perspectives on cooperative learning: A reconciliation. Child Development, n58, p1161-1167.

Smith, M. B. (1968). School and home: Focus on achievement—developing programs for the educationally disadvantaged. New York: Teachers College Press.

Standing Mary. (1996). Effects of a copy, cover, and compare procedure on multiplication facts mastery with a third grade girl with learning disabilities in a home setting. Education & Treatment of children, v19, n4, p25-34.

Sugland, Barbara W., Zaslow, Martha., & Nord, Christine Winquist. (1993). Risk, vulnerability, and resilience among youth: In search of a conceptual framework. Washington, DC: Child Trends, Inc.

Sussell, A., Carr, S., & Hartman, A. (1996). Building a parent/school partnership. Teaching Exceptional Children, v28, n4, p53-57.

Tan, Kuang-Ting. (1995).The research of Native Taiwanese teenagers' culture identification and learning behaviors. Information of Educational Research, v3, n6, 102-114.

Tobias, Randolf. (1992). Nurturing at-risk youth in math and science: Curriculum and teaching considerations. Indiana: National Educational Service.

Tudge, Jonathan., & Hogan, Diane. (1997). Social change, socio-economic status, and the development of self-direction in children: A comparison of Russia, Estonia, and the United States. North Carolina: The European Congress on Psychology (5^{th}).

Turnbull, Ann P. & Turnbull, H. Rutherford (2001), Families, Professionals, and Exceptionality—Collaborating for Empowerment. Merrill Prentice Hall.

Van Luit, Johanners E H., & Schopman, Esther A. (2000). Improving early numeracy of young children with special education needs. Remedial & Special Education, v21, n1, p27-40.

VanTassel-Baska, Joyce. (1998). Planning science programs for high ability learners. Virginia: ERIC Clearinghouse on Disabilities and Gifted Education.

Volkmann, Mark J., & Eichinger, David C. (1999). Habits of mind: Integrating the social and personal characteristics of doing science into the science classroom. School Science and mathematics, v99, n3, p141-47.

Vygotsky, L.S. ([1930-1935] 1978). Mind in society: The developmental of higher mental processes, eds. & trans. M. Cole, V. John-Steiner, S. Scribner, & E. Souberman. Cambridge, MA: Harvard University Press.

Wang, Ling-Ching. (1992). The relative factors of teenage school adaption in minority. National Chengchi University Master Thesis.

Wu Tien-Tai. (1992). Teachers` fostering and pursuing further education in areas of special backgrounds. Hualien: Research Center of Hualien Teachers College.

Yang, Hslao-Jung. (1992). The collection of information and analyzing research of problems concerning Native Taiwanese's education. Taipei: Ministry of Education.

Yu, Hui-Mei. (1993). The investigated research of private and public school students' family financial support about education in Taiwan. National Kaohsiung Normal University Master Thesis.